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THE

INTERNATIONAL ENCYCLOPÆDIA

OF

SURGERY.

VOL. V.

THE

INTERNATIONAL ENCYCLOPÆDIA

OF

SURGERY

A SYSTEMATIC TREATISE

ON THE

THEORY AND PRACTICE OF SURGERY

BY

AUTHORS OF VARIOUS NATIONS

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EDITED BY

JOHN ASHHURST, Jr., M.D.
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ILLUSTRATED WITH CHROMO-LITHOGRAPHS AND WOOD-CUTS

IN SIX VOLUMES
VOL. V.

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PREFACE.

THE Fifth Volume of the ENCYCLOPÆDIA continues the discussion of surgical affections arranged according to the Regions of the Body in which they are observed, embracing Articles on Injuries and on Diseases of the Head; on those of the Eyes, of the Ears, and of the Nose; on those of the Face, Cheeks, and Lips; on those of the Mouth, Fauces, Tongue, Palate, and Jaws; on the Surgery of the Teeth; on Injuries and Diseases of the Neck and of the Air-passages; on Injuries of the Chest; on Diseases of the Breast; on Injuries and Diseases of the Abdomen; and on Hernia. The Sixth Volume will complete the consideration of Regional Surgery, and will supply certain articles which have been unavoidably omitted from the places which it was originally intended that they should occupy, such as that on Diseases of the Bones, by Professor Ollier, of Lyons, and that on the Treatment of Deformities, by Mr. F. R. Fisher, of the Victoria Hospital for Sick Children, London.

Since the appearance of the Fourth Volume, the Editor has lost by death one of the earliest and most enthusiastic promoters of the Encyclopædia, a man universally loved and respected—the late Professor S. D. GROSS—*clarum et venerabile nomen.* It had been hoped that he would live to complete for the Encyclopædia the History of Surgery which he had so courteously agreed to furnish, and the production of which would have worthily crowned his record of long and brilliant literary labor. This hope has been disappointed; but the Editor thinks himself most fortunate in having been able to secure as Professor Gross's successor, a gentleman—Dr. G. J. Fisher, of Sing Sing, N. Y.—who is widely and justly distinguished for his erudition, and for his thorough familiarity with the History of the Surgeon's Art.

Two other deaths among the Editor's collaborators must be briefly referred to: that of the late Dr. J. MARION SIMS—a genius in surgery, and the man to whom more than to any one else American Gynæcology owes its present proud position—and that of the late Dr. CHARLES T. HUNTER, whose long and painful illness, and early death, arrested his useful and honorable career just when he was apparently about to reap in widening reputation and increasing practice, the rewards which he had so justly earned by skilful and conscientious but unostentatious labor, and by strict and unflagging attention to every duty which devolved upon him. The careful and practical character of Dr. Hunter's professional work is well illustrated by his article on Minor Surgery, in the first volume of the Encyclopædia; that on Ovarian Tumors, etc., which Dr. Sims was expected to furnish, has been kindly undertaken by Dr. Paul F. Munde, of New York, whose name is a sufficient guarantee for the ability and thoroughness with which the work will be accomplished.

JOHN ASHHURST, JR.

PHILADELPHIA,
2000 WEST DELANCEY PLACE,
November, 1884.

ALPHABETICAL LIST OF AUTHORS.

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INJURIES OF THE CHEST.

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HERNIA.

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THE INTERNATIONAL ENCYCLOPÆDIA OF SURGERY.

INJURIES OF THE HEAD.

BY

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Injuries of the Scalp.

Contusions and wounds of the scalp are among the most common injuries of civil life. A preliminary consideration of the anatomy of the scalp will explain certain pathological peculiarities of injuries of that structure.

The coverings of the skull, from without inward, are the skin, superficial fascia, aponeurosis and muscular bellies of the occipito-frontalis muscle, subaponeurotic cellular tissue, and pericranium. The integument is firmly bound to the subjacent muscle and aponeurosis by the so-called fascia, which consists of firm, interlacing bundles of fibrous tissue, in the interspaces of which are little pellet-like masses of granular fat, forming an exceedingly inelastic structure. In this ramify the numerous vessels and nerves of the scalp. A consideration of these anatomical points explains several well-known clinical facts, viz., that the inelastic, subcutaneous cellular tissue can actually be *indented* by a blow; that scalp wounds which do not penetrate the aponeurosis seldom gape to any extent; and that when a scalp-flap is formed, it necessarily carries its entire blood-supply with it, owing to the physical characters of the subaponeurotic cellular tissue which I shall presently consider. The origin and attachments of the aponeurosis and muscular bellies of the occipito-frontalis should be carefully borne in mind, as a knowledge of them renders easy the differential diagnosis between subaponeurotic collections of pus and erysipelas. The posterior bellies of the muscle arise from the outer two-thirds of the superior curved lines of the occipital bone, and from the mastoid process of the temporal. The space between them is occupied by the aponeurosis, which is attached to the occipital protuberance and to the inner thirds of the superior curved lines. The anterior muscular bellies are blended with the pyramidalis nasi, corrugator supercilii, and orbicularis palpebrarum on each side. The aponeurosis covers the whole vault of the skull, and is continued laterally by a laminated layer of areolar tissue to the zygoma. Hence it will be seen that subaponeurotic fluid collections cannot pass lower, posteriorly, than the points of attachment of the trapezii muscles; that anteriorly, fluid will gravitate into the eyelids and form a pouch over the root of the nose; and that laterally, the zygomatic arch is the lowest point attainable for a purulent collection. The cellular tissue which forms the bond of connection between the aponeurosis and the pericranium is exceedingly lax, permitting the former with its firmly adherent integument to glide readily over the calvaria. It will be at once seen that a wound penetrating the aponeurosis, on account of this laxity of the cellular tissue, will gape, and if raised in the form of flap may be extensively displaced.

The vascular and nervous supplies of the scalp must not be forgotten with reference to the arrest of hemorrhage, and the neuralgias that occasionally follow injuries. The arteries of the scalp are derived from the temporal, occipital, auricular, supra-orbital, and frontal. Vessels arising from these trunks penetrate the deeper structures to ramify in the periosteum. The veins of the pericranium and of the scalp, the diploic veins, and those of the dura mater, or even the cerebral sinuses, intercommunicate, thus presenting in their cellular coats a continuous tract of connective tissue, along which external inflammation may travel to the diploë, and even to the brain. The nerves of the scalp are the occipitalis major and occipitalis minor, the auriculo-temporal, the posterior auricular, the supra-orbital, and the facial.

CONTUSIONS OF THE SCALP.—Owing to the anatomical structure of the scalp, certain peculiarities of form are presented by contusions, which sometimes give rise to difficulties in diagnosis. The swelling from a blow upon the scalp occurs within a few seconds, and is due to the rapid effusion of blood and serum. It is sharply defined, and does not insensibly blend with the surrounding parts. If examined within a few hours, a soft, central depression is felt, surrounded by a hard, elevated margin, giving the impression of a depressed fracture; and this is all the more deceptive if, as in some instances, a ruptured artery communicates with the effusion, when the sensation communicated to the hand closely simulates that of cerebral pulsation.[1] The central depression with the surrounding hard margin, receives its explanation from the character of the dense, inelastic, cellulo-adipose, superficial fascia, which is *indented* at the point of impact, while the displaced fat, with the surrounding parts infiltrated with blood and serum, forms the hard margin.

The *diagnosis* between this condition and a depressed fracture, can be made by pressing firmly with the finger at the bottom of the depression; if there be no fracture, the surface can be still further indented, when the bone will usually be detected smooth and undepressed. The indurated margin itself can also be indented by pressure with the finger nail, which would not be the case in fracture. There are, besides, no symptoms of cerebral compression. It must be confessed, however, that, in certain instances, experienced surgeons have cut down expecting to find a depressed fracture where none has existed, and again, that, after the effusion has been absorbed, a depression has been found where none had been supposed to exist. Attention to the diagnostic points just detailed should render such mistakes of rare occurrence. The degree of the contusing force may be so slight that the consequences pass away within a few hours, or so severe as to actually pulpify the scalp, although gangrene is of rare occurrence.

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[1] J. L. Petit gives an account of two such cases. Œuvres complètes, p. 334. Paris, 1844.

Complications and Sequelæ.—Contusion of bone, cerebral concussion, rupture of a scalp-artery, intra-cranial hemorrhage, and erysipelas may complicate contusions of the scalp. Abscess, neuralgia, cephalhæmatoma, traumatic aneurism, and pyæmia—the latter usually the result of bone-contusion—are occasional sequelæ. Numerous other after-effects of scalp contusions have been described, but they are really the results of injuries of the scalp-nerves, of an undetected cranial fracture, or of secondary brain lesions.[1]

Treatment.—Quiet, for cerebral complications may arise; cold, evaporating lotions, such as spirit and water, or muriate of ammonium in solution—or even a bladder of pounded ice, if the effusion tend to spread, or pulsate—and attention to the state of the bowels, amply suffice for the majority of cases. If suppuration occur, the treatment should be that of an abscess elsewhere. If a traumatic aneurism form, compression or acupressure of the vessel should be resorted to. Erysipelas, cerebral concussion, contusion of bone, and pyæmia, will be considered in connection with wounds of the scalp.[2] Neuralgias must be treated upon general principles, or by excision of the scar, if they prove obstinate.

Effusions of Blood.—These may occur, 1, in the dense subcutaneous tissue, where the blood forms a hard, unyielding lump; 2, in the subaponeurotic cellular tissue, either (*a*) circumscribed, or (*b*) diffused, when it sometimes forms a swelling of considerable extent, giving a crackling sensation when pressed by the finger; and 3, beneath the pericranium. In the last two situations, these collections have been called *cephalhæmatomata.* The nature of the contents varies with the time after the accident at which they are examined. The blood may "be arterial or venous, in a more or less fluid state; or a thick, viscid fluid of a dark, bistre color; or bloody serum with clots; or serum alone."[3] The wall of the cavity, originally formed by condensation of the environing tissues, eventually becomes lined with a serous-like, secreting membrane. Sometimes the sac is lined with layers of "fibrine" (lymph?) presenting the appearances found in a consolidating aneurism, or in a solidified bursal tumor.[4]

Cephalhæmatomata.—Certain examples of the so-called *caput succedaneum* of the newly-born, the result of tedious or instrumental labor, are entirely or chiefly filled with blood, although from their rapid disappearance the majority certainly seem to be due merely to serous effusion. A caput succedaneum is usually described as being subaponeurotic, but Agnew considers this to be an error, and believes that the majority are simply subcutaneous. When these swellings, due to effused blood, are diffused at the outset, they must certainly be of the subaponeurotic form; but when circumscribed from the first, they may be either subcutaneous or subpericranial.

Subaponeurotic cephalhæmatomata occur in the form of soft, fluctuating tumors, usually situated over one parietal eminence.[5] The margins of the swelling are somewhat indurated. Although considered almost peculiar to the newly-born, they are, according to Gant, of frequent occurrence in older children as the result of falls or blows.[6] I have myself seen a very large one upon the head of a boy about thirteen years of age.

Subpericranial cephalhæmatomata are of very rare occurrence, according to

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[1] Gross, System of Surgery, 6th ed., vol. ii. p. 21.

[2] See page 4.

[3] Hewett, Holmes's System of Surgery, 3d ed., vol. i. p. 574.

[4] See Hewett, ibid.; and Vol. II., page 696, of this Encyclopædia.

[5] Bryant records a large one over the occipital bone. Manual for the Practice of Surgery, 2d Am. ed., p. 154.

[6] Science and Practice of Surgery, vol. ii. p. 147.

Vogel, not being found oftener than once or twice in a thousand births. They are more common after first labors, and, according to Bouchard, more common in boys than in girls, in the proportion of 34 to 9.[1] Commonly situated over one or other parietal bone, they are not infrequently multiple. They are usually small, being seldom larger than a walnut. A distinguishing peculiarity is the fact that, owing to the firmer adhesions of the periosteum at the sutures than elsewhere, these tumors are always confined to *one* bone, never passing a suture. Universally believed to be confined to the newly-born, as indicated by the terms Cephalhæmatoma neonatorum and Thrombus neonatorum, Gant reports the case of a child five years old, in whom a blood-tumor formed as the result of a blow over the right frontal eminence, and presented all the characteristics of a subpericranial effusion.

The characteristic symptoms of the lesion are apt to be obscured by the œdematous swelling of the superjacent scalp, for the first few days after birth, but from the fourth to the sixth day, a soft, circumscribed, fluctuating swelling confined to one bone—usually the right parietal—can be readily detected, while the overlying scalp is not discolored. The centre is soft, while the circumference is hard, and has very much the feel of a margin of bone surrounding a depressed fracture. There are, however, no brain symptoms when firm pressure is made at the bottom of the depression, and by the same manœuvre the finger can often detect the sound, undepressed bone.

Valleix has shown, from his studies of the pathology of this affection, that the hard, crater-like margin is due to the formation of plastic and osseous matter between the pericranium and the bone, and that, upon the side of the cavity, it has abrupt, almost perpendicular, walls, while the outer margin of the ring insensibly slopes down to the level of the surrounding bone. The pericranium is elevated by the blood-effusion from the subjacent bone, both structures being covered with plastic matter, but otherwise healthy. Sir James Simpson has observed that at times the plastic effusion upon the under surface of the pericranium becomes ossified, when pressure upon the resultant thin plate of bone communicates a crackling sensation to the finger.

The *diagnosis* of cephalhæmatomata, both general and differential, has been sufficiently indicated in the foregoing descriptions, except as to the necessity which may arise of distinguishing between pus and blood. In the former case, the collection would appear at a later period than a blood-effusion, and only after precedent symptoms of inflammation.

Treatment.—This should in no wise differ from that advised for contusions of the scalp. If, as occasionally is the case, the swelling persists, or even increases, aspiration, or a valvular puncture, may become necessary, after which firm compression should be kept up over the site of the swelling for a considerable time. The sac will sometimes refill, again and again, requiring repeated tappings. Should the fluid be or become serous after several tappings, and tend to re-form, an injection of iodine may be tried. If pus form, either spontaneously or as the result of attempts to get rid of the effusion, free incisions, followed by the use of antiseptic injections and dressings, should not be delayed.

WOUNDS OF THE SCALP.—These may be incised, punctured, contused, or lacerated. *Incised wounds* differ in no respect from those of other regions. *Punctured wounds* are more apt to be followed by trouble, because the vulnerating body punctures the various planes of tissues forming the scalp at points which do not correspond, owing to the freedom of movement enjoyed by the occipito-frontal aponeurosis, and, in consequence, the resultant effusions cannot get vent, but become widely diffused, setting up the most violent inflammation in those of intemperate habits, or with constitutions broken down from any cause. Even those in apparently robust health do not always escape. *Contused and lacerated wounds* are usually the result of heavy blows, such as falls, blows from bludgeons, etc. Because a wound appears clean-cut, as if incised, it cannot always be inferred that the vulnerating body was sharp, as, owing to the firmness of the subjacent bone, a fall on a plane surface will oftentimes give rise to wounds which closely resemble those made by cutting instruments. I merely mention this fact on account of its medico-legal bearings. These wounds when extending through the aponeurosis, gape markedly, and most extensive flaps may be formed, the scalp falling down over the face, upon the back of the neck, etc. Even the ears are sometimes torn off with lateral flaps. Usually a large portion of these wounds unites by first intention, and where this fails, healing by granulation completes the cure. As these flaps carry their entire vascular supply with them, sloughing is very limited, and the most mangled, bruised-looking scalp-tissue may recover its vitality. It is a golden rule to let nature, not the surgeon's knife or scissors, determine what portion of an injured scalp shall be removed. Portions of the pericranium may also be torn off with the flap, or destroyed, by the body producing the injury. But even extensive denudation of the bone does not necessarily involve exfoliation of the external table of the skull, for in most instances the separated flap adheres. If primary union fails, either granulations cover in the bone from the surrounding tissues, or the outer table becomes vascularized from the diploë, so that sometimes merely small scales are thrown off, while at other times no osseous tissue can be detected in the discharges.[1]

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[1] Erichsen, Science and Art of Surgery, Am. ed., vol. i. p. 529.

Prognosis.—Scalp wounds are chiefly dangerous from their complications, which will be presently considered. Even complete scalping, with removal of the pericranium, may be recovered from.[2]

Treatment.—If the wound be of any size, the scalp must be shaved in its vicinity. Careful search having been made for any foreign bodies, or for a possible fracture, the wound should be thoroughly cleansed with some antiseptic solution, the best being mercuric bichloride, one part to two thousand. I have not mentioned the arrest of hemorrhage, which is usually free, because if it have not ceased from exposure to the air and washing with the bichloride solution, the subsequent dressing with compresses and bandage will usually be all that is necessary. If this do not suffice, both ends of the divided vessels can usually be readily either twisted or tied. Sometimes the ends retract into the dense fibro-cellular tissue, where they can be best secured by passing a needle armed with a ligature around the vessel, including some of the surrounding tissues. Ligatures are rarely necessary except when the patients are drunk and unruly, when I have known them to pull off the dressings and start the hemorrhage afresh. A wound involving the lower part of the temporal fossa may, however, give rise to hemorrhage which may prove difficult to arrest. "Should the bleeding recur and become dangerous, notwithstanding all our local means, the question of applying a ligature to the external or to the common carotid artery may arise."[3] Various measures have been recommended for coaptating scalp wounds. If of moderate size, and not gaping much, small locks of hair on opposite sides of the wound may be passed through perforated shot, which can then be clamped, as Agnew suggests. I have achieved the same result by tying together locks of hair, and fixing them with collodion. Owing to the rapid growth of hair, it is difficult to make adhesive plaster hold for any length of time, while the flowing blood interferes with its proper application at the primary dressing. I prefer, therefore, where sutures are deemed unadvisable, to fix one end of a strip of fine gauze or mosquito-netting with collodion on one side of the cut, when the wound can be accurately coaptated, and held so by painting the other end of the gauze-strip with more collodion, the drying and consequent fixation of the dressing being hastened by blowing with the breath. In this way the most extensive wounds can be as accurately approximated as by means of sutures, and almost as rapidly. With such a dressing at our disposal, sutures are rarely demanded. I am not opposed to their use when deemed necessary—at points of great traction, or in drunken or unruly patients—but anything like an attempt to closely sew up a lacerated scalp wound is to be deprecated, owing to the great ease with which the subaponeurotic fascia permits the diffusion of inflammatory products. Although as a rule I believe sutures to be unnecessary, with the above restrictions I should advise their use, provided that the anatomical peculiarities of the parts be borne in mind, and the sutures cut on the first symptoms of inflammatory swelling. Whatever the means used in closing the wound, care should be exercised lest the edges become inverted, as the hairs in their growth will interfere with healing. Contact of the flap with the deeper parts being secured by proper compresses, which also tend to prevent any collection of inflammatory products, a few folds of lint wet with a bichloride-of-mercury solution, and covered with waxed paper or oiled silk, should be laid over the line of the wound, and the whole firmly bandaged in place.[1] Where any special dressing is not available, I have seen the best results from coaptating the wound by bandaging with dry compresses. Whatever the dressing, I would advise inspection of the wound at the end of forty-eight hours, when it can be either redressed, or left undisturbed, according to circumstances. Quiet, and attention to the state of the bowels, should be enjoined in view of possible cerebral complications.

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[1] See page 8 for treatment of denuded external table by drilling into diploë.

[2] Agnew, Principles and Practice of Surgery, vol. i. p. 257.

[3] Hewett, Holmes's System of Surgery, 3d ed., vol. i. p. 570.

When suppuration takes place, the pus, if situated in the superficial fascia, forms circumscribed collections, which heal kindly after evacuation; but when the abscess is subaponeurotic, it will be diffused, and must then be freely opened at the most dependent points to insure free drainage. Should this condition escape early recognition, the scalp may slough, or, more probably, the aponeurosis with its subjacent tissue, when the pericranium is almost certain to be more or less destroyed, imperilling the vitality of the outer table of the skull. Incisions, when made, should run parallel to the course of the occipito-frontal fibres.

COMPLICATIONS OF SCALP WOUNDS.—*Erysipelas.*—This affection has been already treated of in so exhaustive a manner, in Vol. I. of this work, as to render superfluous anything further than the indication of those peculiarities, due to the tissues in which it arises, which the disease presents, and the modifications in treatment which the concomitant injuries demand. It certainly is most apt to occur in drinkers, or in those with broken-down constitutions. The most common form is the cutaneous, which is rarely grave, and which may be ushered in by symptoms that are somewhat puzzling. Thus, I have lately had a case of trephining, in which violent headache, coated tongue, vomiting, steadily rising temperature, and the presence of a few enlarged and tender lymphatic glands, preceded, by more than forty-eight hours, a marked attack of erysipelas, which was chiefly facial, and which, when I saw it, did not seem to affect the neighborhood of the wound. This precedence of the general over the local symptoms, and the implication of the lymphatic glands, should be borne in mind in head injuries, when otherwise unaccountable, feverish symptoms arise.

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[1] The bichloride gauze, when at hand, may be substituted; or carbolized gauze, or carbolized solution.

In the *treatment* of this affection, attention to the bowels, nutritious food, stimulants, in those accustomed to their use and when not contra-indicated by the cerebral conditions, and iron and quinia, are all that need be resorted to. At times the patient experiences relief from the burning, tingling, cutaneous pain by the application of cloths wet with lead-water and laudanum, or with simple mucilage of sassafras pith.

Phlegmonous erysipelas, a much more serious affection, is apt to be ushered in by marked constitutional symptoms.[1] It shows itself at first by slight puffiness near the wound, without redness of the skin. From plastic effusion, the scalp soon becomes greatly thickened and indurated, and, if unrelieved, the disease may lead to extensive sloughing of the cellular tissue, the aponeurosis, the pericranium, or even the scalp itself. In consequence, the bone may be extensively denuded, and in certain cases more or less necrosis follows, although this is no more a necessary result than it is where wounds denude the bone.

Diagnosis.—From simple accumulation of pus or inflammatory products beneath the occipito-frontalis, erysipelas can be usually distinguished by remembering the points of attachment of the aponeurosis. Subaponeurotic pus may be accompanied by reddening of the skin somewhat beyond the attachments of the aponeurosis, but unless really complicated with erysipelas, the blush does not attack the ears, cheeks, etc. The pus can gravitate no lower than the zygoma, the upper eyelids, the attachments of the pyrimadales nasi, and the superior curved lines of the occipital bone behind, pouches being formed above the root of the nose, the zygoma, and the superior curved lines of the occipital. This condition, with the superficial blush which sometimes extends more over the face than I have described, has been often mistaken for erysipelas and attributed to the use of sutures, but it is in reality simply a dermatitis, due to retention of inflammatory products, which commonly declines when the imprisoned fluids have been drained away.[2]

As regards the *treatment* of phlegmonous erysipelas of the scalp, at the first onset of the local symptoms all stitches must be removed, the edges of the wound separated at a sufficient number of points to insure a free exit for the effused fluids, and poultices or water-dressings, covered with oiled silk or waxed paper, applied. The bowels should, if necessary, be opened by an enema or a mild saline purge, and the treatment just advised for the cutaneous variety of erysipelas, at once instituted. Despite these measures, should the plastic effusion extend, multiple punctures of the scalp, or, at most, numerous small incisions, will prove of advantage, and are not so likely to lead to free bleeding as the long incisions sometimes advised. Anything like free oozing, even from the punctures, must be checked as soon as possible, since these patients cannot afford to lose blood. In persons of previous good health, the relief of tension effected by these incisions usually suffices to prevent extensive sloughing, yet at times great destruction of cellular tissue, aponeurosis, and pericranium takes place, although from the peculiarities of the blood-supply of the scalp, already adverted to, this structure is rarely destroyed, at least to any considerable extent. A rare accident is the laying open of a large arterial trunk by ulceration, giving rise to hemorrhage, the source of which is often difficult to ascertain, owing to the accumulation of blood beneath the scalp. Pressure upon the main trunks of the scalp arteries should be tried in turn, until the right vessel is detected, when it may be compressed, acupressed, or tied.[1] A generous diet, iron and other tonics, carbonate of ammonium, and large quantities of stimulants, are, from the outset, often necessary to tide bad cases over the worst; but treated in the way described, it is astonishing how well they eventually do, the extensively separated scalp becoming adherent to the deeper structures, and the denuded bone being covered in by granulations. When the efforts of nature seem unequal to the task of vascularizing the denuded external table of the skull, left bare by the sloughing of the pericranium, the surgeon may drill with an awl a number of small holes close together into the diploë, and through these, as I have seen in a case of Agnew's, granulations may sprout.[2] The use of disinfectant injections beneath the separated scalp, counter-openings for the escape of pus and sloughs, and the application of compresses to prevent bagging of matter, are too manifest therapeutic indications to need more than this mention.

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[1] Local symptoms may precede the constitutional.

[2] Tetanus is an occasional complication. The reader is referred, for details, and a thorough consideration of all the varieties of erysipelas, to the article on that subject in Vol. I.

Injuries of the Skull.

Contusions of Bone.—Those complications which render injuries of the scalp most formidable, originate, for the most part, in contusions of the skull. Caused, as they not unfrequently are, by slight blows, falls, injuries from spent balls "removing perhaps only the hair,"[3] etc., the resultant symptoms, delayed and insidious, often escape detection until hopeless complications have supervened. Bone-contusion may result in one or all of these conditions: 1, rupture of the bloodvessels may occur between the pericranium and the bone, resulting in an effusion of blood, and secondarily of inflammatory effusions, which strip the membrane from the skull to a varying extent; 2, the same accidents may happen to the vessels running between the dura mater and the inner surface of the skull; and 3, the sinus-like veins of the diploë may be either bruised or ruptured, or the cancellous tissue itself may be broken down, the more elastic compact tables of the cranium escaping manifest injury. In the first two instances, the contiguous bone, deprived of one of its chief sources of blood, is apt to become necrosed with consequent suppuration. In the third case, an osteo-myelitis results which probably goes on to necrosis, suppuration, implication of the dura, and even of the brain and its membranes. In most instances, more than one of the conditions co-exist, usually the first and third. The osteo-myelitis[4] set up by contusion may be observed under three conditions:—

1. It may occur as an acute disease, limited to the site of injury;
2. It may also be seen as a chronic affection, lasting for years, and resulting in either limited or general, irregular thickening of the inner or outer tables of the skull, or of both, causing perhaps, when the inner table is affected, epilepsy or maniacal seizures, provoked, most probably, by some temporary

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[1] Agnew (op. cit., vol. i. p. 257) ascribes this advice to Hewett.

[2] This operation originated with a French frontier surgeon, and was said to have been so extensively practised in cases of scalping, and with such uniformly good results, that soon after its introduction every frontier post had persons who performed it. (Eve, Remarkable Cases in Surgery, p. 35. Philadelphia, 1857.)

[3] Gant, op. cit., vol. ii. p. 148.

[4] I prefer the term osteo-myelitis rather than osteitis, as the diploë sooner or later becomes affected.

increase of the chronic irritation; or necrosis of the outer or inner table may result, and even the whole calvaria may ultimately separate.[1]

3. Osteo-myelitis, caused by a severe blow upon the skull, may also result in an atrophic condition.[2]

Symptoms of the Acute Form.—After a head injury involving a contusion of bone, the patient may at first complain of nothing, or at most of a persistent, dull headache. The next symptoms noted are, that not earlier than the sixth day, and usually not later than three weeks[3] after the receipt of the injury, the patient begins to complain of malaise, headache, slight vertigo, abnormal acuity of the special senses, muscular feebleness or rigidity of the cervical muscles, fever, slight chilliness, and nausea or vomiting. The pupils are usually contracted. If there is a wound, the edges become everted, the previously healthy discharge becomes thin, ichorous, and gleety, the granulations lose their florid aspect, and become pale, and the periosteum secedes from the bone, leaving it dry, white, and discolored. If there is no wound, the site of injury becomes tender, and the scalp infiltrated with serum, producing a circumscribed, flattened, elevated swelling, the so-called "puffy tumor" of Pott, which indicates a subjacent suppurative periostitis, denuded bone, and in many instances subcranial suppuration with separation of the dura mater. The exceptions to this rule are not infrequent, and will receive future consideration. With these local conditions the constitutional keep pace, as indicated by increasing fever. Headache, delirium, drowsiness, and stupor steadily increase; one pupil is perhaps dilated while the other is contracted; and paralysis and convulsions may supervene, coma and death closing the scene.

In addition to the above, irregular chills, followed by high temperature; profuse sweatings; a rapid, feeble pulse; pain in the chest, with dyspnœa and cough; slight jaundice; and swollen, painful joints, may, one or all, be superadded to the local and general symptoms first described. If the disease do not pass beyond a certain point, recovery may ensue, although the patient is liable to suffer, according to Gant, from chronic cerebral irritation, epilepsy, imbecility, impaired vision or hearing, aphasia, and various palsies.

Let us inquire to what pathological changes these symptoms correspond. At first, there is a simple osteo-myelitis, with separation of the pericranium and slight constitutional reaction. The inflammation next spreads to the dura mater, which may have been separated by an effusion of blood caused by the original injury. Lymph and pus soon form. The inflammation, if unchecked, next attacks the arachnoid, when at once the process, up to this point circumscribed, extends over the free surface of that membrane. The visceral layer of the arachnoid soon becomes involved, and then the pia mater, and even the corresponding portion of the brain itself, become inflamed. Here we have a local inflammatory process, first producing bone suppuration and necrosis, then meningitis, and finally localized brain compression by intrameningeal or cerebral suppuration and abscess. When the second class of symptoms are superadded, such as rigors, dyspnœa, etc., or when they have existed coincidently with those first given, the veins of the scalp or diploë near the injury will be found filled with pus. Hewett also says that "the veins on the surface of the hemispheres are sometimes loaded with pus, and so too, and much more commonly, is the superior longitudinal sinus." In other words, we have the symptoms of pyæmia superadded to those of local osteo-myelitis of the cranium, intracranial suppuration, meningitis, and cerebral abscess. Pyæmia may arise from a simple scalp wound, but bone contusion from a slight head injury is the most common cause. I have described the symptoms of intracranial suppuration, meningitis, etc., with those of pyæmia, since although the brain and its membranes may remain perfectly healthy, the association of the two morbid conditions is much more common. The diagnosis between them, especially in their earlier stages, when no signs of pyæmia exist in other parts of the body, is exceedingly difficult.

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[1] "Dr. Abercrombie mentions a case in which the inner table alone of the calvaria was thus extensively destroyed." (Holmes's System of Surgery, vol. i. p. 571.) In Norris's case, the disease attacked both tables of the whole of the calvaria, and extended even as far as the foramen magnum. (Transactions of the Medical Society of London, vol. i. p. 168.) But of all cases of this kind, Saviard's is the most extraordinary. In this case, two years after a blow upon the head, the whole skullcap came bodily away. (Nouveau Recueil d'observations chirurgicales, p. 386. Paris, 1702. See also Œuvres de Sabatier, tome ii. p. 400. 1796; Agnew's Surgery, vol. i. p. 260.) The assumption that constitutional syphilis has anything to do with these extensive exfoliations of bone, Agnew considers entirely gratuitous.

[2] Agnew, ibid.

[3] On the average, about the thirteenth day. Dease thought that between the eighth and sixteenth days was the period most to be dreaded. (Observations on Wounds of the Head, etc. Dublin, 1760.)

Diagnosis.—In intracranial suppuration the earliest symptoms are apt to be those of meningeal and cerebral irritation, such as slight vertigo, headache, abnormal sensibility to light and sound, rigidity of the cervical muscles, broken and restless sleep, and a hard pulse of increased frequency. Subsequently, when symptoms of cerebral compression and paralysis occur, the diagnosis is usually clear enough. Upon the other hand, when pyæmia arises from suppurative osteomyelitis, it is so commonly preceded or attended by intracranial suppuration, that I think that many cases have been correctly regarded at first as non-pyæmic, which afterwards have become septic, so that we are left in doubt to which disease any one symptom or set of symptoms belongs, and are thus deprived of reliable data for a differential diagnosis. Pyæmia, although attended by malaise, slight headache, fever, etc., is not usually preceded by signs of cerebral irritation, but is succeeded by them. I must candidly confess that the distinctions which I have emphasized can be rarely drawn in practice as sharply as I have indicated them, but I am convinced that when a differential diagnosis is possible in the early stages of these affections, it can only be made by following out the line of thought and investigation just suggested. As to the value of the "puffy tumor" of Pott, I would say that it is simply indicative of a suppurative periostitis, or osteomyelitis, and that upon its appearance alone, or the spontaneous secession of the periosteum in an open wound, we cannot predicate separation of the dura mater and subcranial suppuration; but if such appearances coincide with paralytic, irritative, or convulsive symptoms on the opposite side of the body, supposing that the injury is in the anterior parietal region, the probabilities amount nearly to certainty that trephining will reveal subcranial or subdural suppuration, either immediately beneath, or near the diseased bone. Upon the other hand, should, in a case of bone contusion, the local signs of what the older authors thought subcranial suppuration, occur over the occiput, with hemiplegia or other paralysis, or convulsive movements on the side of injury, trephining would do no good, and the bone changes would really only be indicative of local periostitis, with injury or disease of some distant part of the encephalon.[1] A reference to the section on cerebral localization will indicate the facts upon which I found these conclusions.[2]

Treatment.—This should be mainly preventive. In any head injury involving a chance of bone contusion, the case should be closely watched, for, as has been well said, no injury of the head is so slight as to be despised, nor so great as to be despaired of. The simplest diet and quietude should be enforced, a watch being kept for those slight signs of meningeal irritation which have been mentioned.

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[1] Liston, Lectures on the Operations of Surgery, etc., edited by Mütter, p. 76. Philadelphia, 1846.

[2] See also sections on traumatic meningitis, cerebritis, etc.

The bowels should be kept freely opened. Should persistent headache with slight fever be detected, I should advise in the robust—and I would not draw the line too strictly—a rigid anti-phlogistic regimen and wet-cupping, or even venesection from a large orifice, the patient sitting upright. In cases where these measures seem contra-indicated, a full dose of calomel, followed by purgatives, low diet, and arterial sedatives, should be resorted to. Calomel in small doses should be exhibited sufficiently often to touch the gums in either class of cases. Cold to the head, and large doses of the bromides, are indicated, if the cephalalgia be marked. The plan of treatment suggested is opposed by some surgeons, upon the plea that many cases really prove to be pyæmic, and that in that event it would be prejudicial. I would ask how many cases of pyæmia from head injury recover under any plan of treatment? Doubtless some cases where the advice here given is followed, will be treated with unnecessary activity, but I maintain that no permanent harm will result, while some lives may be saved. I am not one of those who think that the loss of a few ounces of blood is a serious matter, having demonstrated, experimentally and clinically, its power of cutting short traumatic inflammation in its early stages. Once again, I only recommend these measures in the incipient stages of meningitis following bone contusion. Hewett considers that the cases which do well under this treatment, are really instances of meningitis " beginning not in the dura mater, but in the visceral layers of the brain, and dependent upon . . . concussion." He may be right, but I think that the mere recovery of such cases is no valid argument against the correctness of the diagnosis. As the earliest symptoms indicative of commencing suppuration between the dura mater and bone, are those of incipient meningeal irritation, they should be so treated, especially as death results in such instances by extension of the inflammation to the meninges and the brain itself. I cannot help believing that in some instances the formation of pus between the dura mater and the bone is prevented. Suppose that the case is not seen until intracranial suppuration has taken place, what shall the surgeon do? If, as mentioned under the head of diagnosis, there is a reasonable probability of the presence of a subcranial or subdural abscess, he should trephine at once, and with a large instrument. Pott's success was due to early, bold operation, and is explicable by the fact that in his cases the diseased process was circumscribed, that is, was incipient.[1]

There is no reason why similarly favorable cases should not be met with nowadays, with equally prompt operative interference. Knowing as we now do that Pott's local symptoms are merely the signs of a periostitis or osteomyelitis, and that cerebral localization can at least inform us that no localized subcranial suppuration at the site of injury can possibly account for the symptoms in certain instances, the trephine will be withheld in many cases that were uselessly operated upon in the past, and in some rare instances I believe that in the future the instrument will be used to evacuate pus from beneath an externally healthy bone, far distant from the injury and from the local signs of bone contusion. What if no pus between the dura mater and the bone be found? If the membrane pulsate normally, nothing beyond abandonment of the operation remains, unless the symptoms are such as would warrant puncture of the brain-substance. If the dura mater bulge up into the trephine-hole—perhaps even to the level of the external bone—and be without pulsation, it should be cautiously incised to give vent to subjacent pus. Sometimes this procedure, by the removal of pressure over the abscess, permits the pus of a true cerebral abscess to make its way to the surface.

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[1] Pott, Injuries of the Head, pp. 63–107. 1768.

Schmucker[1] narrates the case of a grenadier who fell and struck his head against the corner of a stone, whereby a compound depressed fracture of the frontal bone was produced. On the following day trephining, with removal of the splinters and elevation of the bone, restored consciousness. The patient was in the best of spirits until the fifth day, when feverish symptoms set in, followed in twenty-four hours by bulging of the dry and brown dura mater into the trephine-hole. Puncture evacuated upwards of a tablespoonful of laudable pus from a superficial abscess of the brain. The symptoms disappeared, particles of the brain-tissue were cast off, and the patient was well in two months.[2] (Gross.)

A child of nine years, suffering from a compound depressed fracture of the frontal bone, was trephined by Petit.[3] Fever with headache set in on the night of the fifth day, and on the following day the discolored and distended dura mater bulged into the opening. On being laid open, a tablespoonful of brown, fetid fluid escaped, but the symptoms increased until the night of the eleventh day, when the rapid improvement disclosed that a large abscess had burst, and had saturated the dressings with offensive matter. In two months the cure was complete. (Gross.)

In certain rare instances, where the surgeon has had good reason to believe in the existence of cerebral abscess, incisions into the brain-substance itself have been successfully made.[4] The previous use of the exploring needle—or, better yet, the aspirating needle—would be proper in such cases. I shall now give the details of some cases of intracranial abscess treated by incision of the dura mater, which will indicate what seems to me the proper plan to be pursued under similar circumstances:—

An officer was struck on the occipital protuberance by a musket-ball. Symptoms of irritation of the brain having set in, Giersch applied the trephine, under the supposition that there was a fracture of the internal table, but the bone was found to be sound, and there was slight purulent effusion beneath it. On removing the dressings a few hours subsequently, the prominent dura mater was punctured, and a considerable amount of bloody matter evacuated. Rapid and complete recovery ensued.[5] (Gross.)

A man struck his head against the corner of a writing-desk, and suffered from severe headache for several months. Mursinna removed three circles of the occipital bone and opened the dura mater, with the effect of giving vent to a very offensive yellowish fluid, which he regarded as a collection of disorganized blood.[6] (Gross.)

De La Peyronie trephined the parietal bone of a lad for symptoms which made their appearance on the twenty-fifth day after a blow from a stone. On incising the inflamed dura mater, three and a half ounces of pus, which extended by the side of the falx down to the corpus callosum, escaped.[7] Death occurred in a few days. (Gross.)

Mr. Dumville, of Manchester, removed a circle of the denuded frontal bone, for supposed abscess of the dura mater, three weeks after a scalp-wound. The membrane was inflamed and perforated at one point, from which, after the insertion and withdrawal of a probe, stinking matter spurted out.[8] The patient recovered. (Gross.)

A man, aged 37 years, was struck over the supraorbital ridge, and marked symptoms of compression set in at the end of three weeks. Prof. Hughes applied the trephine at the injured spot, and found fragments of the inner table of the frontal bone depressed on the dura mater, without involvement of the outer table. Upon incising the dura mater and evacuating a quantity of pus, there was an immediate return to consciousness.[9] (Gross.)

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[1] Vermischte chirurgische Schriften, Bd. i. S. 283.

[2] This, as well as the following cases, is quoted from a paper on Compression of the Brain, by Prof. S. W. Gross. (Am. Jour. Med. Sciences, new series, vol. lxvi. p. 40–74.)

[3] Traité des maladies chirurgicales, t. i. p. 91. 1790.

[4] See page 000, *infra*.

[5] Rust's Magazin für die gesammte Heilkunde, Bd. ii. S. 127.

[6] Bruns, Handbuch der practischen Chirurgie, Abth. i. S. 937.

[7] Hist. de l'Académ. Roy. des Sciences, p. 212. 1744.

[8] British Med. Journ., vol. ii. p. 743. 1858.

[9] Iowa Med. Journ., 1868, p. 34.

What, then, are the indications for or against the use of the trephine, when the diagnosis of intracranial suppuration from bone contusion has been arrived at? In the present state of our knowledge, I think that all we are warranted in saying is that the operation is both justifiable and, when performed early, likely to prove a valuable resource in several conditions:—

1. If, with a wound over the parietal bone, particularly when involving its anterior half, there are the local symptoms,[1] with hemiplegia, hemispasm, etc., of the opposite side, especially if only the upper or lower extremity is involved, trephining is clearly indicated.

2. If, with wounds over other portions of the skull, symptoms of intracranial suppuration supervene, with neither distinct paralysis nor muscular spasms restricted to one-half of the body, but with general convulsions, or convulsions upon one side and paralysis upon the other, the local symptoms being well marked, trephining may be tried, and in some instances, when done early and freely, may save life.[2]

3. When there are symptoms clearly referable to the neighborhood of the fissure of Rolando, whether there be local signs of bone trouble or not, I think that, in otherwise desperate cases, we may properly trephine at the points which will be indicated when treating of cerebral localization, with a fair prospect of finding pus, either between the dura mater and bone, or subdural, or cerebral. The prospects of success are in direct proportion to the limitation of the motor disturbances.

I consider that the operation, at the point of injury, is positively contraindicated in the two following conditions:—

1. When the so-called local symptoms of intracranial suppuration, or the wound, is situated either over the frontal or the occipital region, with hemiplegia, hemispasm, or partial paralysis or spasm of the limbs, upon either the side of injury or the opposite half of the body.

2. When, with a wound over the parietal region, either with or without the local symptoms, the motor disturbances are on the side of the injury. In either of these cases it is useless to trephine at the site of the wound.

If pus wells up from the diploë while trephining, the prognosis is bad, as the case will probably prove pyæmic.

If trephining were a dangerous operation *per se*, I should be more chary in recommending it; but I hope to show hereafter that in itself, when skilfully performed, it adds little to the danger of the case. When dealing with cases which are almost inevitably fatal if unrelieved, I feel that even temerity is justifiable; much more a comparatively safe operation, which, even if it do no good, can result in no great harm.

In a general way, the following points may prove useful in forming an opinion:—

As a rule, the symptoms produced by the formation of pus between the dura mater and skull do not begin to appear before the sixth day, nor later than the beginning of the third week; those of suppurative meningitis usually appear about the eighth day, and are rarely delayed beyond the twenty-first; while those of cerebral abscess, except in rare instances, are not noted before the end of two weeks, and most commonly set in about the twenty-fifth day.

If purulent infection supervene upon bone contusion, nothing more can be done surgically than to evacuate pus wherever it is accessible, whether in the joints, the cellular tissue, the serous sacs, or the skull. Medically, a vigorous, supporting treatment, with opiates to secure rest, should be resorted to. Mineral acids with bitter tonics are useful to check the diarrhœa sometimes present in blood-poisoning. Although pyæmic cases are usually fatal, occasionally one ends favorably, so that no efforts should be spared to prolong life.[1] Hewett thinks that kidney disease may be at the bottom of the pyæmia, as well as of the erysipelas, of head injuries. With renal complications, he thinks that the serous sacs are more apt to be attacked.

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[1] "Puffy tumor;" or secession of the periosteum, if there is a wound.

[2] Chirurgical Works of Percival Pott, F.R.S., ed. by Sir Jas. Earle, F.R.S., vol. i. p. 82. Phila., 1819.

2. *Symptoms of the Chronic Form of Osteomyelitis.*—Beyond the bony enlargement, nothing but local tenderness with slight hyperplasia of the scalp can be detected, although from thickening of the inner table of the skull, epilepsy, mania, etc., may result.

Treatment.—The administration of iodide of potassium, either alone or combined with mercury, incisions, leeching, the local application of iodine, and repeated blisterings, may be tried. When a localized exostosis forms, after the delay of a few months to see whether its growth will not cease—as so frequently happens—it may be removed with the saw or bone-forceps. If necrosis result, the case should be here, as elsewhere, left to nature until the bone separates, when the sequestrum may be removed by appropriate incisions. The question of trephining for epilepsy will receive future consideration.

FRACTURES OF THE SKULL.—Fractures of the skull are naturally divided by anatomical peculiarities and pathological results into two classes, viz., those of the vault, and those of the base. A fracture of the vault, however, very often coexists with one of the base, and in fact some writers take the extreme view that this is always the case. That this is an error, I hope to demonstrate. Fractures of either class may be fissured, incised, punctured, comminuted, or depressed.[2] Those of the vault may involve the external table alone, with crushing of the diploë; or the internal table may be comminuted and depressed, without any apparent injury of the external table; or the fragments may be elevated above the level of the sound bone. Finally, fractures of either class may be simple, that is, without any wound of the soft parts communicating with the fracture, or they may be compound, that is, with a lesion of the soft parts leading down to the injured bone.

One important difference between compound and simple fractures must be here adverted to. In the former, the force being almost of necessity applied to a small portion of the skull, the fracture is more frequently strictly limited to the point struck than in simple fractures, where the force is so diffused as not to be sufficient at any one point to divide the integuments. Thus in eight cases of compound fracture out of twenty examined, the fracture corresponded to the point struck, while this was found to be the case in only one instance out of fifty-six examples of simple fracture.

The anatomy of the scalp has already been sufficiently dilated upon to explain certain appearances presented by head injuries. A little reflection will indicate what an important part it plays in protecting the skull from fracture, its mobility converting many a direct into a glancing blow, thus avoiding fracture, or modifying its extent. The frangibility of skulls varies exceedingly. Other things being equal, the thinner the skull the more brittle, usually from the almost complete absence of diploë. Some skulls are translucent throughout nearly their entire extent, and are mere shells of compact tissue. Other skulls may average half an inch in thickness. Comparatively thick crania, however, may be quite brittle, but a thin one is always so for the reason just given, that is, the deficiency of diploë.

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[1] I have found digitalis invaluable in cases of exhausting surgical disease, with frequent feeble pulse and high temperature. It is specially useful when the secretion of the kidneys is deficient, or likely to become so.

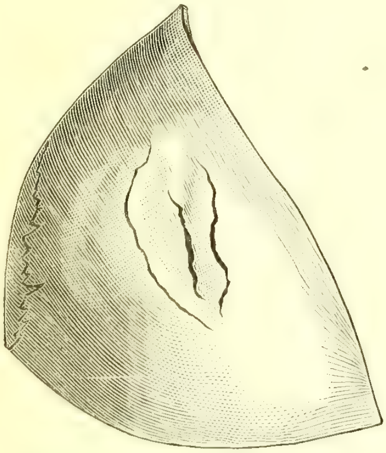
[2] Holmes's System of Surgery, vol. i. p. 582.

At the outset, I wish to emphasize the fact that a fracture of the skull has no inherent danger, over and above similar injuries of other bones; indeed, not nearly as much if we except the peculiar arrangement of its diploïc venous channels, which predisposes to purulent infection. I repeat again, a fracture of the skull *per se* is not a dangerous injury, and I thus reiterate the statement in order to point out the error, too often made, of concentrating attention upon the fracture instead of upon the concomitant cerebral injuries, and because so much has been written concerning the risk of converting a simple into a compound fracture by incising the integuments, when the former presents symptoms of cerebral compression, forgetting that, though making a fracture of the thigh compound, directly imperils the patient's life, the course of the injury, as far as life is concerned, differs little in compound and simple fractures of the skull, provided that intracranial inflammation can be avoided.[1] I do not deny that intracranial complications may be aggravated by a reckless admission of air to a previously simple cranial fracture, but I deny that with modern antiseptic precautions the danger of the operation is to be compared to the risks of intracranial inflammation from the irritation of depressed fragments of bone, and that any comparison can be justly drawn between a compound fracture of a long bone and one of the skull.

I. Fractures of the Vault of the Skull.—These are usually the result of the direct application of force to a limited area of the skull, the bone yielding at the point struck. The resultant injury may be (1) a simple fissure, which is usually not limited to the site of injury, but may extend through several bones and even reach the basis cranii, and (2) a comminution of the bones, which varies in extent, but which, resulting, as it most often does, from violent, concentrated force, is usually pretty much limited to the point of impact.

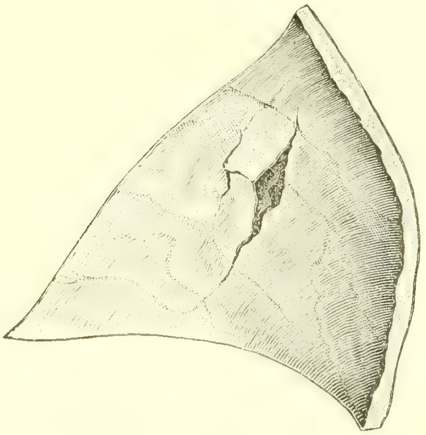
Although comminution commonly results from the application of concentrated force, occasionally diffuse force will produce the same result. Thus, I have examined the skull of a negro which reminded me of the appearance of an egg dropped from a height. The comminution was the most extensive that I have ever seen, and was the result of blows from the head of another

Fig. 816.



Indentation and fissuring of outer table of skull.

Fig. 817.



Fracture of inner table of skull. From the same specimen as fig. 816.

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[1] Pyæmia more commonly follows contusion of bone than it does fracture.

negro, who had seized the victim by the lapel of his coat while he butted him. The skull would have been thin for that of a white man, and was singularly so for that of a colored one. Fissures of the surrounding, comparatively uninjured bones, not uncommonly coexist with comminuted fractures.

Indentation or fissuring of the outer table only, is occasionally met with, but, as a rule, even these slight injuries are accompanied by much more extensive splintering and depression of the inner table of the skull, as shown in Figs. 816, 817, from a specimen in the Mütter Museum. This result, which is observed in all fractures of the skull from direct force, is mainly due to the fact, pointed out by Teevan, that the bone yields first on the side of extension.[1] Thus let E F, in Fig. 818, represent a segment of the calvaria, and the space G, included between the parallel lines, represent the portion of bone struck. The portion of bone G yields to the blow, to a much greater extent than the portions of bone E and F, which in consequence may be considered as practically unmoved. The result is that the osseous tissue of the upper, convex portion of G is much compressed, while the lower, concave surface tends to be straightened out, or extended, with a consequent rupture of the bony fibres, and, the force continuing to act through the medium of the compressed outer table and diploë, the fragments of the inner table are depressed, the points C and D being widely separated. (Fig. 819.) Unquestionably, as stated, the bone thus yields first and most markedly upon the side of extension; and the want of support afforded by the soft cerebral mass, with the resiliency of the whole skull, causing its over-recoil, explains the relatively extensive depression of the inner table produced by comparatively slight blows. A glance at Fig. 820 will explain this, as well as the mechanism of fractures of the internal table alone. The double lines represent the secondary positions assumed by the skull just after the force has ceased to act, the dotted lines the primary effects of the blow, and the single black lines the condition in which the parts finally remain. Hence it will be seen, that the fracture commencing upon the side of extension, the fragments of the inner table remain almost undisturbed in the position in which they were left by the blow, while the outer table regains its normal level, owing to the mutual compression of its component parts, and to the fact that

Fig. 818.

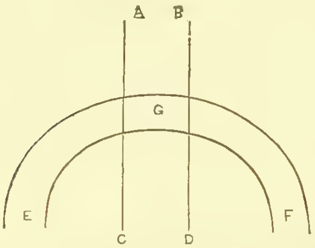
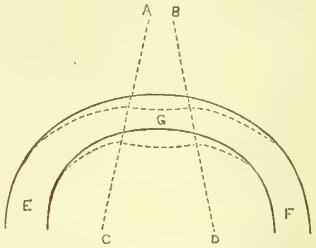


Fig. 819.



Diagrams illustrating mechanism of fracture of the inner table of the skull. (After Teevan.)

Fig. 820.

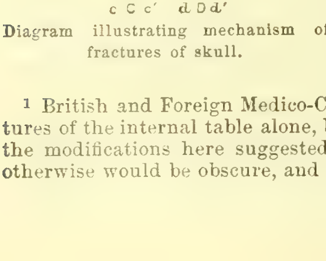


Diagram illustrating mechanism of fractures of skull.

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[1] British and Foreign Medico-Chirurgical Review, vol. xxvi. Teevan's paper deals with fractures of the internal table alone, but the mechanism is the same for complete fractures, and, with the modifications here suggested, his explanations will serve to elucidate certain points which otherwise would be obscure, and which have very commonly been erroneously interpreted.

the comparatively undisturbed surrounding bone serves as immovable abutments to the straightened arch. If there is a depression without actual fracture of the outer table as well as of the inner, the force has been such as, by partially crushing them, to overcome the resiliency of the bony fibres of the outer table and the diploë, and thus prevent restoration of the arch form. The truth of Teevan's views as to the bone yielding first on the side of extension, is proved by the fact that blows inflicted upon the *inner* table of the skull, will cause more extensive shattering of the outer table than of it.[1]

A fissure of the outer table may be so slight as to escape close scrutiny, while the inner table has been extensively comminuted. After careful search in one instance, the fissuring would have been overlooked had it not been that a minute tuft of hair was imprisoned by the fissure when the impacting force made it gape widely. In a case reported by Dr. P. H. Watson, a tuft of hair was found in a portion of skull bared by what had been supposed to be only a scalp-injury, the fissure having been originally wide enough to allow the passage of a thin flake of lead from a passing ball, which was found, after trephining, lying upon the dura mater.[2] Fissured fractures are the only variety of such injuries which occur by *contrecoup*, or counter-stroke; they may be very extensive, separating the upper from the lower part of the skull, or its anterior from its posterior segment, by extending through the base.[3]

There is one portion of the vault where extensive splintering and depression may occur without any involvement of the inner table, and that is in the region of the frontal sinuses. As these cavities do not exist until at or after puberty, and do not attain oftentimes any great size until after twenty-five years of age, fractures of this region must be most carefully examined. Even in advanced adult age, the frontal sinus may exist only on one side, or there may be a large sinus on one side of the median line and only a minute one on the other. Again, the frontal sinuses may be large enough to lodge a musket-ball without injury to the inner table of the skull. Race has something to do with the development of these cells, which are peculiarly large in the full-blooded African.[4]

Fracture of the inner table of the skull is a very uncommon injury, and more often results from blows of glancing bullets[5] than from the accidents incident to civil life. Still it may occur from blows by stones, sticks, or cricket balls, and the possibility should not be lost sight of, as the danger to life of these injuries is very great. In one case reported by Mr. Edwards,[6] fatal intracranial hemorrhage occurred as the result of laceration of the middle meningeal artery by a scale of the inner table. The external table of the skull was intact. The mechanism by which these fractures are produced has been already explained. Fig. 821, from a specimen kindly placed at my disposal by Dr. J. F. Holt, of Philadelphia, exhibits the appearances seen in such cases.

Although the broken fragments may remain at the same level with that of the healthy bone, they are generally upon a deeper plane, that is, are depressed. Still more rarely in civil life, the fragments may be *above* the level of the sound bone, as in a case reported by Hewett, where a chisel fell from a height, cutting and bending outwards a trapdoor fragment, including the whole thickness of the skull. In the Mütter Museum of the College of Physicians of Philadelphia, there is one specimen from a case in which a circular-saw accident elevated a large fragment, and another from one in which a blow from a hatchet did the same, but appears to have completely separated the fragment, which, sliding down, has become co-ossified there, leaving a permanent opening through the occipital bone. (Fig. 822.) Sabre-cuts not uncommonly produce similar elevations of the broken bone.[1] "In the Museum of the Royal College of Surgeons there are ten skulls which have suffered from very severe slicing cuts. . . . . . The portions of bone thus sliced, and they are large pieces, were once detached, and afterwards reunited a little out of their proper places."[2]

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[1] Loc. cit.

[2] Edinb. Med. Journal, July, 1870.

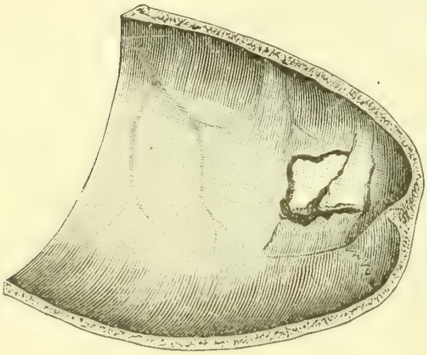
[3] Sir A. Cooper, Lectures, ed. by Tyrrell, Am. ed., p. 131. 1839.

[4] Hilton, Lectures on the Cranium.

[5] Twenty such cases are reported in the Med. and Surg. History of the War of the Rebellion. See also Guthrie's Commentaries on the Surgery of War, 6th ed. p. 322, etc. 1862. Pott, Dease, Deane, S. Cooper, Weeds, and others, report cases. There is a well-marked specimen of this form of fracture in the Mütter Museum. Similar cases are also to be found in the works of Paré and other writers.

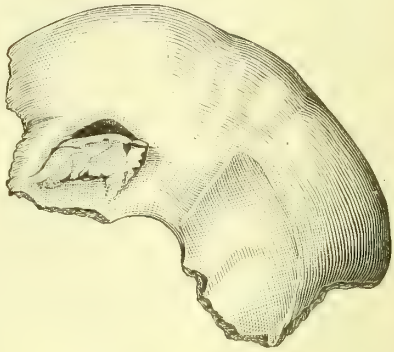
[6] Edinb. Med. Journ., vol. viii. p. 191.

Fig. 821.



Fractures of inner table of skull.

Fig. 822.



Fracture of occipital bone by hatchet-wound.

Incised fractures, the result of cutting instruments, are, however, rare in civil practice, although cuts with hatchets, knives, and circular saws occasionally produce such injuries. Sword cuts, especially when the weapon is very sharp, may shave off a slice of bone involving only the outer table, as in a specimen in the Army Medical Museum, or they may penetrate no farther than the diploë, as in a case observed by Dr. F. H. Gross, of Philadelphia, where a shoemaker's knife stopped just short of the inner table. This fact should be borne in mind, as there may be no necessity for cutting through the whole thickness of the skull to remove imbedded fragments. When both tables of the skull are involved, especially in hatchet and axe wounds, the inner table is apt to be extensively comminuted and depressed in a linear manner. The only specimen with which I am familiar, showing an exception to this rule, is that of which I have already spoken, where the sword was evidently exceedingly sharp, and made a number of almost clean cuts, without any appreciable splintering of the inner table. A probe introduced sideways beneath the fragments will sometimes demonstrate this separation of the inner table by detecting its presence at a lower level.

Punctured fractures present two broad varieties, viz., those inflicted by sharp, and those inflicted by dull instruments. It will be seen that the distinction is not a superfluous one, when I explain that when the wound is made by a narrow, smooth, sharp instrument, such as a penknife-blade, there may not be the slightest splintering or depression of the inner table, if the instrument be driven in at right angles to the planes of both tables, while if it enter obliquely, there is apt to be merely a curling down, as it were, or at most a splitting off, of a small scale of the inner table; but that when the vulnerating body is dull, such as a piece of stick, a cane-ferule, the corner of a brick, or a blunt-pointed nail, the fragments of the outer table and diploë are carried in, wedging apart and extensively comminuting the inner table.

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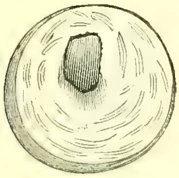
[1] Cooper, op. cit., p. 132.

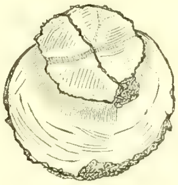
[2] Guthrie, op. cit., p. 362.

Fig. 823.



Disk of bone removed by trephining, showing punctured fracture of skull. (From a specimen in the museum of the New York Hospital.)

Fig. 824.



The same as Fig. 823, showing fracture of inner table.

There is then a difference in the conditions of these two varieties of punctured wound, which explains the different course pursued by them in many instances. Penetrations of the skull, especially of the vault, by penknife-blades, fragments of glass, etc., may divide large branches of the meningeal artery and cause fatal hemorrhage.[1] It must not be thought that only pointed instruments can produce punctured fractures. The essentials, both mechanical and clinical, of a punctured fracture, consist in circumscribed injury of the outer portion of the skull, with extensive shattering of its inner table. Thus I have been compelled to trephine a young man who had broken his skull by a fall against the corner of a square iron nut. The injury to the outer table was most insignificant, while the inner table was broken up for a considerable extent into minute fragments, the number of which would never have been suspected by the uninitiated, from an inspection of the injury to the outer table. Sabre and hatchet cuts thus present all the essential peculiarities of punctured fractures.

Depressed fractures, involving both tables, present certain varieties of form which I shall now point out. One of the most common is that seen in the accompanying cuts from a specimen in the Mütter Museum. (Figs. 825, 826.) Here an ovoidal piece of bone, split into halves, has been driven down upon the brain. Owing to the longitudinal fissuring and firm impaction of the fragments in their slanting relation to one another, there must have been very marked pressure exerted upon the membranes and the brain; much more indeed than would appear at first sight possible, and more than occurs in other varieties of impacted fracture. This is commonly the result of the application of great force by a heavy body presenting a convex, rather sharp edge, such as a horse-shoe, the edge of a beer mug, a dull hatchet, etc. Sometimes a form of fracture is met with, consisting of a long, single fissure, with marked overriding of one margin of the fractured bone. The most common variety of depressed fracture, however, is that in which a more or less ovoidal portion of bone is broken into a number of triangular fragments, with their apices directed inwards towards the deepest portion of the depression. When most of the fragments are driven down to about the same level, firm impaction generally exists; and even where they occupy different planes, it is oftentimes a matter of surprise to observe how firmly they resist elevation, although further depression may be effected.

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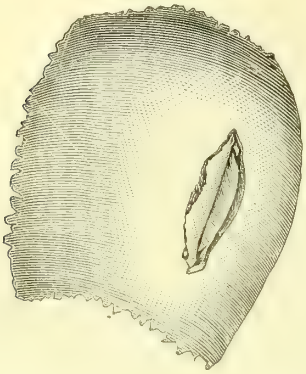
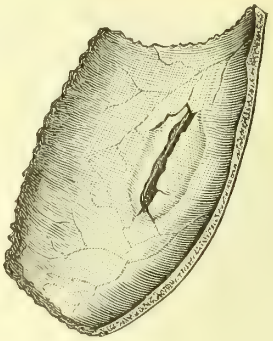
[1] See Fig. 829, *infra*, for an illustration showing a wound of the meningeal artery by a fragment of glass.

Fig. 825.



Depressed fracture of outer table of skull.

Fig. 826.



Fracture of inner table of skull. From same specimen as Fig. 825.

In all depressed, comminuted fractures, the inner table is, as a rule, much more extensively shattered than the outer.

Bending of Bone without Fracture.—I do not believe that traumatic depression of the skull can occur in the adult without fracture. In the child, such an accident has been frequently reported, but as I have been unable to find any account of a post-mortem examination of such a case, I can neither affirm nor deny the fact that none of the bony fibres give way. I am inclined to think, however, that in the young child, before co-ossification of the different cranial bones has taken place, such an accident might occur, with simple rupture of a few of the fibres on the side of extension, but no fissuring of the bone.[1] The most curious distortions of the skull result from these bendings of the calvaria, which are apt to involve a large extent of such bones as the parietal, frontal, or occipital. No fracture can be detected, and the depression is smooth, and commonly ovoidal, although the late Professor Gross reported several cases where some of the normally convex portions of the skull were simply flattened, with exaggerated projection of the other segments. I have seen a long, linear depression, which resulted from a fall against the edge of a marble step. Sooner or later, generally within a few days, these depressions resume their normal level.

Intra-Uterine Fractures of the Skull.—Some authors teach that a blow upon the abdomen of a pregnant female may produce a cranial fracture, but do not bring forward any cases in support of this view. I am exceedingly skeptical of the accuracy of any such observations. Undoubtedly, in tedious labors, with a disproportion between the fœtal head and the maternal bones—however caused—such accidents have been reported. Sometimes the arm has been interposed between the fœtal head and the cranium, while at other times no assignable cause has been manifest. Occasionally the labor is neither tedious nor severe, and the pelvis may be of normal size. The parietals are the bones usually involved, or the parietal and frontal. Sometimes the occipital is broken, and most rarely of all the temporal. Depression is uncommon, the fracture consisting of one or more fissures, from half an inch to one and a half inches in length. Rarely there is marked depression, and cases have been reported where a spiculum of bone could be readily detected through the integument. This must, however, be an exceptional occurrence, as it is probable that a cephalhæmatoma invariably accompanies such injuries.

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[1] The result of examination of fractures occurring during unassisted labor would seem, however, to negative this view. See p. 21.

When not still-born, infants thus injured may recover, when any depression which exists will probably disappear in the course of time.

Diagnosis of Fractures of the Cranial Vault.—There are no certain signs by which we can determine the existence of a fissured vault, when no wound leads down to the bone; and in many cases a post-mortem examination first reveals an unsuspected fissure of the skull. Effusions of blood into the superjacent tissues have induced experienced surgeons to cut down upon supposed fractures, and no fracture has been declared to exist when the skull has really been broken. When lying beneath the temporal muscle, an extensively comminuted fracture may escape the closest examination. Gross relates a case where he was nearly led into error by a congenital malformation of the skull. I have myself been struck, in examining certain heads or skulls, to notice how readily a careless observer might mistake a depressed fontanelle, or one closed by a Wormian bone, for a depressed fracture. Bearing in mind these possibilities, a few inquiries as to the patient's previous history, and a proper examination of the anatomical relation of the parts, will secure against mistake. Absorption of the diploë, and consequent thinning of the skull, may likewise lead to errors of diagnosis.

Compound fractures of the vault are usually readily detected, but this is not always so, as in Dr. P. H. Watson's case, already referred to, where a few hairs, caught in the minute fissure, alone led to its recognition. I cannot agree with Sir Prescott Hewett, when he says that sutures and vascular grooves may be mistaken for fissured fractures even after careful examination, for there is one infallible test, viz., that the line of coagulated blood lying in an uninjured suture, or groove, can always be wiped away, while no amount of rubbing with the sponge will remove the line of blood effused between a fractured bone or separated suture. I have on more than one occasion satisfied myself of the truth of this very ancient observation.[1] Sometimes a line of coagulated blood beneath the edge of the adherent periosteum may appear like a fissure, but as this membrane can be pushed away, the absence of fissure at the site of the blood-line can be readily determined. Gross suggests that the cup-like depression of the outer table should be filled with water, when it cannot be determined whether or not the inner table is fractured as well as the outer. If only the latter be fissured, the water will remain, while if the inner table be also broken, the water will filter away between the fragments. I have never tried this expedient; and although the disappearance of the water would undoubtedly prove an injury of the inner table, its remaining might not disprove comminution of the vitreous layer of the skull.

A foreign body—as a piece of bone—having been driven through the temporal fascia beneath which it remains, may give rise to the erroneous diagnosis of a comminuted, depressed fracture, the margins of the firm fascia feeling like an opening through the bone. The error was in one case only corrected by observing that the supposed skull-fragment presented upon removal a white macerated appearance, and evidently was not a recently detached piece of human bone.[1]

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[1] Hippocrates recommends the application of a solution of the "jet black" ointment to detect fissuring of the skull. Celsus translates this "atramentum scriptorum," and the note to the Sydenham translation of Hippocrates's Works explains that this ink was made of the soot of pines and gum. It is this ancient suggestion, evidently, that has led to the significance of the line of coagulated blood in fissure of the bone being discerned.

Depressed fractures in the region of the frontal sinuses may only involve the outer table. The error has been made of mistaking an exudation of inspissated mucus through a break of the anterior wall of the sinus, for an extrusion of cerebral matter. In these fractures the skin covering the fragments may become emphysematous, especially if the patient blow his nose violently. When emphysema is detected, it plainly indicates the presence of a fracture which at least involves the anterior wall of the frontal sinus.

Prognosis.—This being almost entirely dependent upon the concomitant cerebral lesions and their sequelæ, is uncertain. Linear fractures, with neither depression nor symptoms of compression, usually do well, especially when they are simple. Sometimes, however, such cases are followed by suppuration between the bone and dura mater, though compound fissured fractures of the skull are more apt to be thus complicated. In any event such an occurrence is rare. The course pursued by the case is then similar to that of one of contusion of the skull, under which heading the reader will find the subject fully treated of.[2] The region of the vault affected also affords grounds for prognosis. Thus injuries of the anterior half of the parietal bone are apt to be followed by serious motor disturbances. Depressed fractures, simple or compound, are grave in proportion to the accompanying cerebral symptoms, and when these are absent throughout the course of the case, to the form of the injury. When the depression is slight, smooth, and uniform, the much dreaded secondary results, such as epilepsy and so forth, are far less liable to occur than when the displaced bone is broken into many irregular fragments, which press deeply into, or even penetrate, the brain. These remarks are equally applicable in regard to the chances of encephalitis, although of course no absolute rule can here be laid down, since there may be severe contusion or laceration of the brain with but little primary indication of such an accident, and since with but slight injury to the outer table, the inner table may be much comminuted. Punctured fractures are exceedingly dangerous, and in most cases, when unrelieved by operation, prove rapidly fatal. In this class I would include all fractures which consist of a limited injury of the outer table with extensive shattering of the inner, such as those produced by the corner of a brick, a sword-cut, blows with hammers, pokers, or hatchets.

Although a compound fracture presents some features of gravity that a simple one does not, yet the free drainage, preventing accumulation of inflammatory exudates, and the more probable circumscription both of bone and of brain injury, in many cases do away with much of the apparent difference, and with modern antiseptic precautions the prognosis is materially improved. One of the chief additional risks, putting aside pyæmia, is from hernia cerebri following primary laceration or sloughing of the dura mater. The increased chances of encephalitis from the admission of air, are much lessened by antiseptic precautions, yet they undoubtedly exist. Finally, let me again reiterate that the one great danger to be apprehended is encephalitis, and that, were it not for this, patients with fractures of the cranial vault would convalesce almost as certainly as those with fractures elsewhere. But a clear distinction must be drawn between the encephalitis necessarily resulting from the primary injury, which is unavoidable, and the encephalitis resulting from the pressure upon, and irritation of, the intracranial contents by fragments of bone, which the normal, pulsatory movements of the brain render remarkably efficient as constant sources of irritation.

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[1] Hewett, op. cit., vol. i. p. 582.

[2] See page 8, *supra.*

Treatment.—From the preceding remarks, it is clear that the surgeon's main attention should be directed not to the broken skull, but to the injured brain. Encephalitis results, first, from injury done to the brain and membranes by the fracturing force and the bony fragments. Granted a certain amount of intracranial injury, and inflammation must ensue; but in many cases this unavoidable result can be conducted to a favorable termination by antiphlogistic regimen, and treatment such as was advised for concussion and laceration of the brain. I am desirous of emphasizing the fact that there is a form of encephalitis after fracture of the skull, similar to that met with after head injuries where no bone lesion has resulted, which is inevitable, despite any treatment addressed to the fracture, and which can be combated by general measures alone. At the other extreme, there are cases where the intracranial injury is so slight as to result, *of itself*, in little further trouble, but such cases prove fatal from the constant "fretting" of the brain and its membranes by displaced fragments of bone. The only proper treatment for these cases manifestly is to remove the source of irritation, and with it almost the only cause of inflammatory mischief. In the first class of cases, as elevation of fragments cannot remove precedent injury of the brain, such a procedure only proves useful by preventing secondary inflammation due to the irritation of bony spicula. To this class belong most of the fatal cases of primary trephining, where the operation is wrongly tabulated in statistical tables as fatal; the fact being that the operation, being incapable of restoring a lacerated, ruined brain, merely fails to do any good. But there is an intermediate variety, where the meningeal and cerebral injuries are not necessarily fatal in themselves, but are rendered so by the sloughing and inflammation—perhaps avoidable—which are rendered certain by leaving depressed, lacerating fragments of bone, goading the tissues; patients thus hurt may recover under the effect of rest, with removal of every source of irritation. Here extraction or elevation of the depressed fragments of bone, with appropriate general treatment, is clearly indicated.[1]

Non-penetrating incised wounds must be treated as cases of contusion of bone, after careful removal of any foreign substances, such as, for instance, the point of a knife-blade. When a portion of the calvaria has been sliced off, carrying with it a broad-based scalp-flap, according to most authorities it may be safely turned back, and will probably adhere, provided that free drainage be secured.[2] When the fragment does not seem firmly connected with the scalp, or when the flap-pedicle is narrow, the bone had better be dissected out, and the case then treated as one of compound fracture with loss of bone.

Fissures of the skull, simple or compound, do not call for surgical interference unless symptoms of compression from extravasated blood, or at a later period from intra-cranial suppuration, call for operation.

In compound depressed fractures, unless the fragments are very slightly depressed, the bone should be elevated. Such cases, when left to nature, must be watched with the utmost care, for even when the outer table seems merely bent down in the centre, with capillary fissuring of the margins of the depression, extensive shattering of the inner table may exist. (Figs. 827, 828.) In compound, comminuted, depressed fractures, the surgeon should, in my judgment, always operate at once, to prevent intracranial inflammation: in other words, "preventive trephining" should be resorted to. To wait until symptoms of trouble arise, is to wait until operation can rarely be of any service. Such practice is illogical and opposed to the results of experience. When such cases prove fatal from trephining, they do so from concomitant lesions, not from the operation, if properly performed.

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[1] See sections on Concussion and Contusion of the Brain, and on Encephalitis.

[2] Larrey reports a case where, after replacement of the bone, serious cerebral symptoms arose which compelled him to dissect out the fragment, when recovery took place. In another case he was not so fortunate, death following.

Fig. 827.

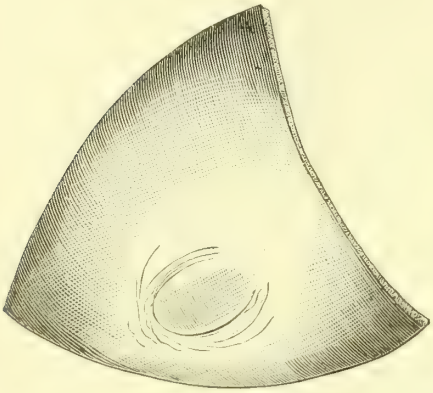
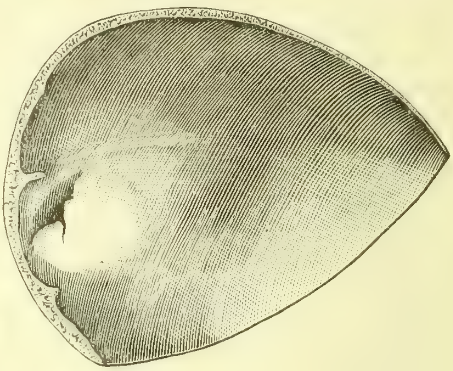


Fig. 828.



Fracture of skull with shattering of internal table. (From a specimen in the Mütter Museum.)

I shall not enter upon the vexed question, whether or not depressed bone produces cerebral compression, as I do not found my advice upon the existence of such symptoms. Besides, experience shows that in many a case in which the patient has been thought to be suffering from compression by depressed bone, the symptoms have really been due to effused blood, which has been successfully removed. Any theoretical views which tend, therefore, to cast doubt upon the possibility of compression resulting from displaced bone (an occurrence which, however rare, has unquestionably been met with),[1] are mischievous, as apt to restrain the elevation of depressed portions of the skull beneath which effused blood or pus may lie. There is one important occasional exception to this rule. When a depressed fracture takes place in the adult over the region of the frontal sinuses, there may oftentimes be an extensive indriving of bone, with no injury to the brain. If, after careful examination, there are good grounds for believing that the inner table of the skull is uninjured, it is advisable to wait, remembering that upon the first symptoms of meningeal irritation an exploratory operation must be performed, and the fragments elevated should any be found depressed.

The surgeon should not await compression-symptoms as an indication for operation in fractures of the vault, as then it often will be too late. Undoubtedly many patients recover in whom the bone is not elevated,[2] but in too many epilepsy, insanity, chronic cerebral irritation, etc., render life a burden, and operations are then required which often prove useless. Modern investigation and experience show most clearly the danger of leaving depressed fragments of the skull *in situ*. Operations for epilepsy show at times that, in the effort to bridge across the irregular fragments, and from the constant irritation due to the cerebral pulsation, driving the dura mater against the bony fragments, nature throws out osteophytic growths which eventually—perhaps after years—set up serious trouble.[1]

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[1] See Sir Astley Cooper's account of Mr. Cline's famous case. (Op. cit., p. 138.) Other cases, quite as conclusive but not as striking, could be cited.

[2] Hennen relates a case "where the man survived thirteen years, with no other inconvenience than occasional determination of blood to the head on hard drinking," and yet there was "a funnel-like depression," one and a half inches deep, "in the vertex." (Op. cit., under Case XXXIX.)

For manifest reasons, punctured fractures of every variety should at once be operated upon, every fragment being carefully elevated or removed. In certain cases of extensive hatchet-wound, where the use of the trephine would result in the removal of too much of the calvaria, and where consequently the case would otherwise have to be left chiefly to nature, Hey's saw may be used to remove a strip of bone upon either side of the wound.[2]

Fractures of the inner table, being unrecognizable by any definite symptom, are not usually detected except after death. The possibility of such an injury being caused by concentrated, violent force, such as a blow from a glancing bullet, from a pebble, etc., will in otherwise obscure cases, when secondary symptoms of compression arise, warrant the application of the trephine at the point of impact[3]—a mode of practice which has occasionally proved successful.[4]

And now what shall be done for depressed, simple fractures? This is the most difficult to decide of all the questions relating to head surgery. In giving the advice I do, I fully feel the serious responsibility that I am assuming. Still, I think that it is both theoretically correct, and, still better, warranted by experience.

In simple depressed fracture, the chief removable primary danger is encephalitis from the irritation of depressed fragments. In such cases if our medical measures fail, the patient can only die, but if he lives without elevation of the depressed portion of bone, a miserable life is too often before him, with chronic cerebral irritation, epilepsy, fatuity, insanity, or even murderous impulses. What shall be done in these doubtful cases?

If the untoward results just described were very unusual, or if the fear expressed of converting a simple into a compound fracture, which, after all is the only valid ground of objection against elevation of the bone, were well founded, there could be no question as to the advisability of non-interference. But I contend that the dangers of a simple, depressed, comminuted fracture are greater than those which follow its conversion into a compound fracture. With the knowledge which we now possess of the great probability that sooner or later nearly every case of depressed skull-fracture will result in epilepsy, or in some form of secondary brain-disease, and since reliable statistics show that trephining itself is not a more dangerous operation than those commonly resorted to in other affections, in order to avert possible dangers less grave than those entailed by depressed fragments of bone, I cannot but think that, with the restrictions which I shall presently point out, it is our duty to advise elevation of a simple, depressed, comminuted fracture of the skull. I think that the opinion which I have expressed is steadily gaining favor among surgeons, and I feel emboldened to express my views by the published opinions of such distinguished and experienced operators as the late Prof. S. D. Gross, and Prof. Moses Gunn, of Chicago.

This return to the practice of our ancestors is more an apparent than real departure from that of the present day. Most surgeons would, I presume, agree with Hewett, when he says that, where the symptoms "are urgent—if they indicate a decided pressure upon the brain—then operative interference becomes necessary." I would simply go one step further and say that to

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[1] Dudley reports a case of epilepsy supervening nine years after the fracture. Operation in this case proved curative. Sir A. Cooper (op. cit., p. 137) also relates an instructive case.

[2] Hey, Practical Observations in Surgery, page 19. Philadelphia, 1805.

[3] Teevan shows that fracture of the inner table always occurs opposite to the point struck. (Loc. cit.)

[4] See page 12, *supra*, for a recovery occurring after trephining, in the practice of Prof. Hughes.

prevent secondary inflammation and late brain-disease, I would operate at once in badly depressed, comminuted, simple fractures, even though they presented no decided symptoms of compression. When, however, the fracture is not extensive, only slightly depressed, and but little comminuted, a primary operation should not be thought of, unless marked symptoms of compression are present. In these cases a little delay may prove that apparent compression is due to slight concussion, etc. General treatment must be relied on, and the strictest watch must be kept for symptoms which are indicative of subcranial suppuration, upon the supervention of which, according to the principles enunciated in a former portion of this article, trephining should at once be performed. If, however, the bone be much depressed and extensively comminuted, so as to press upon and injure the membranes and brain, the margins of the cranial opening being irregular and jagged, an incision should be made, and the case treated as one primarily compound. I consider this to be the best practice, even when no symptoms of compression are present; and of course an operation is still more imperatively demanded when pronounced compression of the brain exists. In all these cases, it is presupposed that the surgeon has arrived at the conclusion that the apparent pressure-symptoms are most probably due either to the depressed bone or to intracranial hemorrhage, and not to diffused injury of the brain.

With careful antiseptic dressings, the minimum of risk results from thus converting simple into compound fractures.

With children, especially very young ones, a different course must be pursued. In many cases there is mere bending, or at least insignificant fracture of the bone. There being no diploë, or at least very little, if the outer table be not comminuted, the inner cannot be much shattered. At what age the skull of a child approaches that of an adult in its behavior when subjected to a fracturing force, I cannot say, but I am convinced that in children under two, and often up to three years of age, the observations just made hold good.

In simple, depressed fractures in children, the bone will either spontaneously resume its level, if recovery ensue, or it may be raised by pneumatic suction if the bones are yielding, as in two cases mentioned by Prof. Gross.[1]

Dr. W. L. Moultrie, of Charleston, S. C., in 1849, had a patient aged five months, with a depression of one parietal bone large enough to contain the bowl of a tablespoon. A cupping-glass having been adjusted and exhausted of air, traction was made upon it with the effect of rapid and complete restoration of the entire surface to its natural level.

A case of a similar nature, in a child two years of age, has been reported by Dr. Nicolls.[2] The depression, a deep narrow one about three inches in length, was promptly raised by a cupping-glass placed upon an embankment of common glazier's putty, in order to afford it a proper purchase.

Complications and Sequelæ.—Encephalitis from brain injury, and intracranial hemorrhage in all its forms, are the chief complications. Pyæmia is rare after fractures of the vault, although it may occur. The great sinuses may be wounded, and the formation of a thrombus, and purulent infection, may follow. Brain-abscess is a not uncommon sequel. The cicatrix formed where there is loss of bone-substance, may in very rare instances be ruptured, hernia cerebri and death ensuing, as in a case reported by Jamieson, where the accident resulted from the violent paroxysms of coughing incident to an attack of whooping-cough.[3] The rent, however, may close, and recovery take place.[4]

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[1] Op. cit., vol. ii. p. 64.

[2] Dublin Med. Press, Sept. 1853.

[3] Med. Essays and Observations (Edinburgh), vol. ii. p. 217.

[4] See Holmes's System of Surgery, vol. i. p. 585.

Where there has been a loss of bone, the gap is usually bridged across only by a dense membrane, into which, however, ossification may sometimes extend for some little distance.[1]

II. Fractures of the Base of the Skull.—Basal fractures may result from either direct or indirect force. Among forms of *direct* violence may be enumerated (1) thrust wounds, by walking-canes, sticks, swords, bayonets, etc., which penetrate the skull through the roof of the orbit or of the nose; (2) a blow upon the chin, which may actually drive one condyle of the jaw through the glenoid fossa; (3) a blow upon the nose, which, fracturing the bones of that part, may likewise shatter the cribriform plate of the ethmoid, as is shown in two specimens in the Mütter Museum.

Thrust wounds most commonly implicate the thin walls of the orbit, the cribriform plate of the ethmoid, the fragile, shell-like body of the sphenoid, and more rarely the occipital bone. Such accidents can readily occur in the roof of the orbit, through which the brain may receive fatal and unsuspected injury, since the vulnerating body may have passed through the retro-tarsal fold of the conjunctiva,[2] producing merely an ecchymotic patch on that membrane; or there may be so small a skin wound that, seeing the vulnerating body to be large, the surgeon may think that not even a penetrating wound of the skin has taken place.[3] In such cases there are probably no brain symptoms for several days, after which they develop sometimes quite suddenly, death resulting, perhaps, in a few hours; or the case may run a longer course.[4]

Murderous wounds, which leave no trace that can be detected except after most careful examination, may also be readily effected by passing a small pointed instrument through the retro-tarsal conjunctival fold, and then penetrating the delicate orbital roof and superjacent brain. This is especially easy in the case of children, but presents no great difficulty even in the adult. The medico-legal bearing of this fact is plain.

Prognosis of Basal Fractures from Direct Violence.—Death is the usual result of these fractures, the autopsy first revealing the nature and full extent of the injury. More rarely recovery has ensued, as in one case where the severe brain symptoms left no doubt of the nature of the injury, and in another[5] where brain protrusion occurred.[6]

Treatment.—The prospects are very bad should any foreign body be left within the skull. An exceedingly instructive case related by Hulke[7] I shall here quote, as it indicates a somewhat important point in practice.

A girl, aged six years, received a punctured wound of the orbit from falling upon a slate pencil which she was holding in her hand. All portions, as was supposed, of the slate pencil were removed by the house surgeon, and the child passed a comfortable night. The next afternoon, when Mr. Hulke first saw her, he detected with the probe a portion of the pencil deep in the wound, enlarging which he exposed the fragment wedged in an opening in the skull. Sufficient of the latter was cut away with the gouge to admit of the removal by the forceps of what was again supposed to be the whole of the foreign body, which proved to be shattered. Encephalitis set in, with high temperature and rapid pulse, until the ninth day, when, after a quiet night, the temperature fell to 97.5° F., and continued subnormal until the sixteenth day, when it suddenly rose to 104° F. Restlessness, delirium, flushed face, screaming, vomiting, convulsions, and coma accompanied this high temperature. Death took place in twenty-four hours, and the post-mortem examination revealed a large abscess of the right frontal lobe, which had recently burst into the anterior horn of the lateral ventricle. In the abscess lay a piece of pencil one inch long.

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[1] There is a specimen illustrating this in the New York Hospital Museum. (No. 24.)

[2] A case of this nature has been reported by Sir A. Cooper, where a pair of scissors penetrated the retro-tarsal fold, with no brain-symptoms resulting for over four days. (Lectures, edited by Tyrrell, Am. ed., p. 131. 1839.) See cases by Sir P. Crampton and J. Paynter, Dublin Quarterly Journal of Medical Science. 1851.

[3] Morgagni, De sed. et caus. morborum, Epist. li. Sect. 58.

[4] Paynter's case, already cited. J. H. Jackson, in the Lancet for Feb. 2, 1884, reports a case of punctured wound of the orbit from a blunt piece of stick, which wounded the lateral ventricle. The stick passed between the inner canthus and the eyeball, leaving only a slight ecchymosis. There were no cerebral symptoms until the fourth day, when they were suddenly developed, death taking place in a few hours.

[5] Morgagni, op. cit., Epist. li.

[6] Lancet, vol. ii. p. 16. 1837–38.

[7] Holmes's System of Surgery, vol. i. p. 586.

Mr. Hulke goes on to say, that, "Cutting away the bone by the gouge effected such a loosening of the splinters of the pencil as to result in a fragment being left behind;" and he expresses regret that a trephine had not been used instead of the gouge. To this latter point of treatment I would call particular attention, viz., the use of the trephine to remove foreign bodies imbedded in the skull, since by it the end in view can be most easily attained, the whole extent of the injury revealed, and removal of all shattered bone, foreign bodies, etc., readily secured. In other respects, the treatment is the same as that for other severe, penetrating head-injuries, which has already been sufficiently described.

The same misleading appearances of the external wound may be present in thrust wounds of the nose. Thus Dr. George Anderson[1] reports a case where, while fencing with walking canes, a man was struck a blow upon the left ala of the nose, which produced a small puncture not larger than a leech-bite. Dying a few days afterwards with evident, acute brain disease, post-mortem examination revealed the brass ferule of a cane, lying close to the left side of the sella turcica, having reached this position by penetrating the body of the sphenoid bone. Although examined by a surgeon shortly after the accident, the nature of the injury was unsuspected.

Fractures of the glenoid fossa from blows upon the chin have been reported. Sir Prescott Hewett gives a drawing of one such case from a specimen. Dr. Lefèvre (de Rochfort) reports the case of a man, aged 22 years, in whom the right maxillary condyle was driven through the glenoid fossa into the skull, by a fall from a great height upon the chin. The patient lived over five months, presenting no other symptoms than pains in the head, and some mental peculiarities which were thought to be simulated until an autopsy revealed the nature of the injury. Then a cerebral abscess, due to the pressure of the maxillary condyle, was found situated at the under surface of the right middle lobe of the brain.[2]

Besides such instances of direct violence, there are others in which, as long since pointed out by David[3] for other parts of the body, it is in reality the fracturing force. Suppose that a man falls from a great height upon his feet or buttocks; what results? Why, practically the condyles of his occipital bone are struck violently through the medium of the spinal column—struck just as directly for mechanical purposes as if with a sledge-hammer. Again, a man falls from a height and strikes full upon the vault in some comparatively yielding substance, such as soft earth. The weight of the body again strikes, through the medium of the spine, a violent blow upon the occipital condyles, thus fracturing them. The fact that such injuries are due to direct force may appear clearer when I say that a blow is merely the exciter of vibrations, and that we must consider the point whence they start as in reality the point of impact.

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[1] Dublin Quarterly Journal of Medical Science. 1851.

[2] Gazette Hebdomadaire. Septembre, 1834.

[3] In his well-known Prize Essay, published in the name of his pupil, Bazille (Prix de l'Académie Royale de Chirurgie, tome iv. p. 420. Paris, 1819). See, also, the same translated in Justamond's Surgical Tracts, edited by Houlston, page 239. London, 1789.

Aran has pointed out that the curved and elastic spine, by its recoil, increases the violence of the shock in such falls as I have just described.

General crushes, where the head is caught between two opposing forces, fracturing the base as well as other portions of the skull, are also clearly fractures by direct force. Sometimes, where the head is thus compressed, the central bones of the base may be the only ones broken.

Fractures of the base may result from extension of fissures of the vault into the base, the "fracture by irradiation" of Fano.

Finally, basal fractures may result from conduction and amplification of vibrations, or by *counter-stroke* (*contre-coup*), as it is commonly called. This form of fracture very rarely occurs alone, but is an efficient factor in certain instances of the preceding class. If by a fracture by counter-stroke, one directly opposite to the point struck is meant, this probably never occurs except when the centre of the vertex is the point of impact. For instance, a violent blow upon the right parietal boss will not produce a fracture at the left parietal eminence, but at the base of the cranium, through one or both petrous bones. The statement commonly made that the vibrations which are excited in the vault travel by the shortest route to the base, is incorrect. The majority reach the base by the "shortest anatomical route," indeed, but that is very different from the shortest route. Again, the opinion expressed by a recent writer, that when the petrous bones are broken from a fall upon the occiput, this is because the "basilar process rests against the apices of the petrous bones" is both an anatomical and mechanical error. These mistakes arise from failing to remember that the various portions of the skull are of varying thickness, and are so constructed for specific ends. If the vault were of even thickness and density, as well as all of the base except its central portions, and if the skull were also a true sphere, then true fracture by counter-stroke might occur; for the vibrations would travel in all directions until—being probably of unequal velocity—when they met at the weak, central, basal portion, it would be disrupted. But the skull is of unequal thickness in different parts; it is not a true sphere; and certain portions of its base, although frequently broken, are in reality the densest and strongest.

It is unquestionably true, that the portion of the skull struck, determines which of the fossæ of the cranial base the fracture will probably traverse, when the fracture is not a severe one.[1] This I hope to explain by certain anatomical peculiarities of skull structure. The theory that vibrations of the brain produce fractures of the orbital plates, is too manifestly untenable to demand refutation.

I need hardly say that the force of the vibrations is directly proportioned to the amount of tissue set in motion. Let any one attempt to hold a heavy iron bar by one end, while the other, lying on an anvil, is struck a powerful blow with a sledge hammer: I think that in most cases the vibrations would force the unprepared hand open, and the bar would fall. Yet, if instead of the large bar a fine wire were substituted, and struck with precisely the same force, probably no vibration would be felt, although vibratory waves would undoubtedly be set in motion in the wire. In like manner, where the skull is thin, the vibrations are almost imperceptible; where thick they are marked. When the vibrations, starting in the thinner portions, reach the thicker, the latter, besides being better conductors of vibration, are actually *amplifiers* of the same.

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[1] In 25 cases analyzed by Hewett, the fracture was limited to one fossa, as follows: the anterior fossa in 5 cases, the middle in 14 cases, and the posterior in 6 instances: of 29 cases in which two of the fossæ were implicated, in 14 the middle and anterior fossæ were fractured, and in 15 the middle and posterior. In 10 out of 64 cases all three fossæ were involved. The middle fossa was fractured in fifty-three of the sixty-four cases examined.

The base must be massive, at least in parts, in order to support the superincumbent weight of the skull and brain, and to afford a firm basis for the movements of the lower jaw, and of the head on the spine, as well as to protect the important nervous structures in relation with it. While this arrangement is advantageous in health, there are compensating disadvantages when man is subjected to violence; indeed, in his ordinary movements this massiveness of portions of his cranial base would be disadvantageous, were it not for certain wise provisions to be presently mentioned. The pericranium without, and the dura mater within, act precisely as a wet wash-leather covering and lining would to a bell, damping vibrations. To the ovoid form of the skull, a large part of the security of the brain is attributed, and to a considerable extent this is true; but one important point is almost universally ignored by writers upon this subject. Endless demonstrations exist, going to prove that any segment of the brain-case is a section of a spheroid, and to this fact the immunity from fracture enjoyed by the skull is attributed. If fractures were produced only by crushing forces, the proposition would be incontrovertible. If however a large part of the damage is done by setting up vibrations in the bones themselves, then the form of the skull only conduces in a slight degree to its immunity from fracture. An arch that will sustain hundreds of tons of pressure, if vibrations are set up in it may readily be fissured, although its form may remain unchanged.[1] The arched form of the skull then merely resists the tendency of the bones to be pressed inward when a blow is struck, and, the vault not breaking, the force expends itself in producing vibrations which cause a basal fracture. Any brittle body will thus be injured whenever the vibrations become violent enough to overcome the cohesion between the particles composing that body. Examining the anatomy of a child's skull will give some useful hints. Probably no young child's skull has ever been fractured by a diffused blow upon the vertex, nor has more than one bone of the vault been broken, unless the force has been actually applied to it. Why is this? In an infant's skull every bone is isolated from every other by membrane, than which there is no better arrester of vibrations. An attentive examination of a parietal or frontal bone,[2] will show that the most projecting portions (those most liable to first strike the ground in falling) are the thickest, while extending from these centres are radii of bone becoming more and more delicate. Each of the fine terminal points of these radii is enveloped by membrane. The vibrations initiated by a blow upon the thicker, central part of the bone are conducted on, or rather have to be propagated, by a gradually thinning structure, that is, one less and less capable of vibrating strongly, until they finally reach the terminal radii of bone which are completely enveloped in membrane, when they are totally arrested. Hence it is that the lines of fracture of an infant's skull never pass beyond the one bone struck. Certain well-known clinical facts are thus explained by the anatomy of the child's skull. As the bones come to be more and more in bony contact, with advancing years, this immunity from radiation of lines of fracture from the point struck is gradually lost.

In the adult skull, the parietal bones and the frontal eminences, instead of being the thickest, are often the thinnest portions of the vault, and the eight component bones of the brain-case are more or less co-ossified, or at least are practically in bony contact. The brain, which fitted fairly well the comparatively smooth base of the child's skull, has now apparently to lie upon a number of irregular and often sharp bony projections, which, to any one examining a fresh brain and a dry skull, would appear to render the brain liable to serious laceration from the slightest jar of the body, while a jump from the height of a few feet would seem to render disorganization of the base of the brain inevitable.

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[1] Basal fractures are practically always fissured, the form of the base remaining unaltered.

[2] The arrangement mentioned can best be seen in a fœtal bone, but exists, although not so easily detected, long after birth.

The mechanical effect of the diploë must now be examined. This is normally absent in certain parts, such as the cerebellar fossæ, the greater part of the squamous portions of the temporal bones, the orbital plates of the frontal, and the floors of the lateral sinuses as they approach the base of the brain. It may also be exceptionally absent in any portion of the vault. A blow upon the vault will set up vibrations of the outer table, which are transmitted to the inner, with much decrease in force by the damping effect of the diploë. The inner table is both a better conductor of vibrations, and also an amplifier of them. Wherever the diploë is present, the vibrations of the two tables pass along to certain denser portions of the skull, which externally are covered with muscle, internally by dura mater and cerebro-spinal fluid, where the waves of motion cease. But when, provided that they are of sufficient violence, they reach a portion of skull where the diploë is absent—just as where the insulating medium is removed between portions of an electric circuit, the spark leaps across, and a "shock" results—so the vibratory waves of differing intensity meet where the two tables become continuous, and a fracture takes place.

But all know that, upon the whole, the brain is the best protected portion of the body. Ignoring many intrinsic provisions for safety, we shall find that, in the fresh skull, the numerous projecting points of the base, instead of endangering the brain, actually protect it. In truth, these projections no longer exist—being covered by dura mater, and rounded off or overlaid by the great venous sinuses and bloodvessels of the part, especially where the greatest dissimilarity would seem to exist between the brain and its case, viz., at the central portion of the base. In addition, at these points the brain is lifted off from the skull by a "water-bed" of cerebro-spinal fluid. Did space permit, I could demonstrate that, where peculiarly dense portions of the skull are in contact with the brain or other bones, cartilage, sinuses, or arteries—that is, membranous tubes filled with fluid, the best possible arresters of vibrations—are interposed. Suffice it to say, that wherever needed such arrangements exist, so that those vibrations, excited in walking, etc., which do not neutralize one another, are safely conducted off to be "damped" by membrane and fluid.

Holding the base of a skull up to the light, the more massive portions will be seen to converge, in general terms, towards the petrous portions of the temporal bones, the anterior and posterior clinoid processes, and the crista galli of the ethmoid. The anterior and posterior clinoid processes, and the crista galli, are thickly enveloped in membrane and immersed in cerebro-spinal fluid. The apex of the petrous bones, and a portion of their inner margins, seem, the former in contact with the sphenoidal body, the latter with the basilar process of the occipital bone. In reality, the apex of the petrous bone is separated from the body of the sphenoid by the plate of cartilaginous tissue which fills the foramen lacerum medium, and by the carotid artery, while the inferior petrosal sinus lies in a groove formed partly by the petrous bone, partly by the basilar process of the occipital bone. Any well-informed anatomist can readily fill in this outline sketch of cranial anatomy. Now set in vibration the skull walls, and what results? The vibrations, indeed, reach the base, but only by the anatomical routes, the nearest preferably, but by all if the blow be sufficiently violent.

I think, then, that a little reflection will convince every reader, that the apparently useless and dangerous projections seen in the dried skull, do not exist in the normal state, but, being specially arranged, serve as the discharge-points for the vibrations which, by mechanical laws, must pass along the best conductors, that is, the densest portions of the bones, while these same conductors are also amplifiers of the vibrations. Physiological vibrations actually serve useful purposes, which I cannot here detail.[1]

The foregoing facts would indicate that Aran and others are wrong in stating that fracture of the base is always accompanied by fissuring of the vault, which is the starting-point of the fracture. If this were true, the greatest force being applied to the weakest portion, the fissures should be widest apart at that point, becoming finer and less widely separated as they reach the stronger portions of the base, but the reverse obtains, and, whether starting in the vault—which I admit is very often the case—or not, the amplification of the vibrations increases the shattering of the base. In slighter basal fractures the vault is not fissured, and even Hewett and Aran confess that the posterior clinoid processes may be broken off, or the roofs of the orbits fissured, without any line of fracture directly reaching them. If, therefore, slight fractures of the base do occur without fissuring of the vault, severer ones, where the vault is injured, may be similarly produced. The separation of the basal sutures shown in a case which I have elsewhere reported, and two specimens in the Mütter Museum, show that it would be impossible to produce the appearances presented if the fracture started in the vault; for then the upper continuation of the sutures would have been most widely separated. The suture could only have been separated as it was, had the fracture started in the vault, by some of the dentations being broken so as to drive one bone below the level of the other. Nothing of this sort was detected; but vibrations acting most forcibly on the base, would force apart the masto-occipital suture as if from within, and would cause precisely the appearances actually seen.

Examining basal contusions of the brain, we shall find that they demonstrate this conduction of vibrations to certain points of the base of the skull. The middle lobes of the cerebrum are most often bruised, next come the anterior, and finally the posterior, "which," says Hewett, "owe their immunity to lying upon the tentorium, while the others are injured by the sharp, irregular projections of the cranial base, which, although rounded off to a certain extent, and smoothed down by the dura mater, are still both sharp and numerous." Now as contusions are frequently found in various portions of the brain without fracture, and as even in basal fractures the bones are very rarely displaced, the only explanation, especially in contusions of the middle lobes, is to consider them as resulting from the conduction to that point of powerful vibrations.

No one who remembers what is really seen in post-mortem examinations of the brain-case, will accept the statement of "sharp, bony projections;" especially when it is borne in mind that the sinuses and bloodvessels are tensely filled with fluid blood during life.

As the occipital condyles often present two separate facets, if the head be extended when a blow is inflicted upon it, or during a fall upon the feet, the force will affect chiefly the posterior facets, while, if the head be flexed, the anterior ones bear the brunt.[2] This goes far to explain, always subject to the laws governing vibrations, why in one case a fall upon the feet, knees, or buttocks, produces a fracture of the anterior, and in another a fissuring of the posterior fossæ. Such cases as a fracture of only the cribriform plate of the ethmoid by a fall upon the feet, are thus explicable by the conduction and amplification of vibrations, the motion-waves being directed almost solely forwards, owing to the peculiar position of the occipital condyles as just described.[1] In the same way, fractures of the apex of the petrous bone and both posterior clinoid processes,[2] and fractures of the petrous bone and side of the sella turcica,[3] with no injury in any instance of the occipital bone through which the force is transmitted, demonstrate beyond doubt the theory of conduction and amplification of vibrations.[4]

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[1] For details, see Hilton's Lectures upon the Cranium, Guy's Hospital Reports, 2d series, vol. viii., p. 351; also a paper by the author, Phila. Med. Times, Oct. 23, 1880.

[2] H. Allen has laid special stress upon the position of the head as determining the portion of the base broken.

The following case, in which the injury was so trivial that it produced no symptoms of any moment, in which the contusion of brain-substance, if any, was at a minimum, and in which no inflammatory symptoms were present, suggests conclusions which I think go far to explain the fatality of basal fractures.

Dr. Charles Wirgman requested me to see with him a young lad who had fallen upon his head when playing leapfrog, but who had walked home with his comrade's assistance, immediately after the injury. When Dr. Wirgman first saw him, slight symptoms of concussion were noted. Next day he seemed better, only complaining of some pain in the head. Upon the third day the improvement was very marked, nothing remaining but a little headache. He begged to be allowed to sit at the window, and, notwithstanding the doctor's injunctions, walked about the apartment, and went to the yard to evacuate his bowels. A few hours after Dr. Wirgman's last visit, he was hastily summoned, and on his way called for me. Upon our arrival we were informed that the patient had suddenly been attacked with vomiting, and that eclampsia and death had almost at once ensued. Post-mortem examination revealed an insignificant ecchymosis over the right mastoid region, the result of infiltration of blood from the line of fracture. On opening the skull, a fissure was found traversing the right petrous bone, and extending forwards from the occipito-mastoid suture, which was separated. A minute blood-clot, a few lines in extent, lay near the fracture, within the arachnoid sac, but otherwise the membranes and brain appeared singularly healthy. Hilton reports similar cases in his admirable Lectures on the Cranium.

As long as such patients remain quiet, as long as no physiological vibrations are excited by efforts at locomotion, just so long does the brain-substance contiguous to the lines of fracture remain uninjured. The primary jarring and slight brain-contusion are recovered from; and, should quiet be sufficiently long maintained, recovery ensues. Let, however, the patient, tempted by his apparent recovery, leave his bed, and immediately the normal vibrations, which must mechanically arise, are excited. Safely conducted away in health, to points where they were annihilated, the course of the vibrations is now interrupted by the fissures, and the superposed brain-substance is jarred and probably slightly lacerated. From such constantly recurring injuries, slight though they be, in the adult, encephalitis results; in the child, perhaps fatal eclampsia.

Symptoms of Basal Fracture from Indirect Force.—Except in cases of direct hurt from thrust-wound, access cannot be had to the site of injury, and in many cases, if this were possible, little could be learned by the touch unaided by sight, as the fragments of basal fractures are rarely displaced, and basal fissures are seldom widely separated. The only symptoms,[1] therefore, upon which we can rely, are the escape of blood, watery fluid, or brain-substance, by some one of the natural passages, and the detection of injury done to the cranial nerves as they emerge from the skull.

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[1] Marmy, Bull. de la Soc. Anat. de Paris, p. 258. 1848.

[2] L'Expérience, Novembre, 1843. (Hewett.)

[3] Marmy, loc. cit., p. 193.

[4] In the Wood Museum (Bellevue Hospital, New York) is an uncatalogued specimen, presented by Prof. F. S. Dennis, showing marked fissuring of the *left* petrous bone from a pistol-shot wound of the *right* ear. It forms a typical example of fracture by transmitted vibrations.

Blood may escape by the nose, from the ears, or from the pharynx. When coming from the nose or pharynx, portions are swallowed, which are often ejected by vomiting. I have seen blood, however, welling up into the pharynx, whence it issued by the mouth and nose, in a steady though small stream. The blood may also escape into the cellular tissue of the orbit and eyelids, into that of the mastoid region, or into that of the back of the head.

Orbital Ecchymosis.—Coming from the back of the orbit, the blood usually first shows itself beneath the ocular conjunctiva, where it may accumulate until it forms a brownish-red, much-elevated margin around the apparently deeply-sunken cornea.[2] According to Hewett, the ecchymosis subsequently spreads to the lids. Velpeau thought that the ecchymosis of the lower lid alone was a sign of basal fracture; but this symptom is of no special value without extensive subconjunctival and orbital effusion, although the lower lid usually becomes discolored before the upper. Upon the other hand, fracture of the anterior portion of the base may exist without ocular ecchymosis, or the lids alone may become discolored.

Marked subconjunctival hemorrhage, coexisting with orbital and palpebral effusion, is then a fairly reliable symptom of fracture of the anterior basal region, if we except those rare cases which have been reported by Holmes, where fractures of the malar or of the superior maxillary bones, produced both ocular and palpebral ecchymosis.[3]

But the total absence of these symptoms cannot exclude a basal fracture. Thus, of twenty-three cases of fracture of the orbital plates of the frontal bone, in eight cases there were no traces of extravasated blood, in either the eyelids or beneath the ocular conjunctiva, while in five cases the lids were alone discolored. In the ten remaining cases, blood was extravasated both beneath the ocular conjunctiva and into the lids.[4] It will be thus seen that when these symptoms are present they are valuable aids to diagnosis, but that their absence is not conclusive in the other direction.

Injuries to the arteries at the back of the orbit have resulted in traumatic aneurisms, which often ultimately demand surgical interference.[5]

Hemorrhage from the Nose and Pharynx.—Epistaxis, from the vascular nature of the Schneiderian membrane, is a common symptom in head injuries, and can only be of any diagnostic value when persistent, and when accompanying symptoms of grave cerebral concussion. In fourteen cases out of thirty-two, where central basal fractures occurred, bleeding from the mouth or nose, or subsequent vomiting of blood, occurred. Out of the fourteen cases in which this symptom was noted, in four the ethmoid alone was involved; in three, the body of the sphenoid; and in one, the ethmoid, sphenoid, and basilar process of the occipital bone were all implicated. (Hewett.)

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[1] Le Gros Clark reports a case of basal fracture, with marked cerebral laceration, in which the temperature was depressed, being 87.4° F. one and a half hours after the injury, and only reaching 90° F. nine hours subsequently. (Gant's Science and Practice of Surgery, vol. ii. p. 162.) Mr. Hulke has reported, in the Lancet for 1877, a series of cases in which, the patients living for some days, an excessively high temperature was developed, without any coarse post-mortem evidence of inflammation being found. In all, however, there was extensive shattering and bruising of bone.

[2] Maslieuret Lagemard first called attention to this subconjunctival ecchymosis.

[3] British Medical Journal, 1855.

[4] Hewett, op. cit., vol. i. p. 589.

[5] Morton, Am. Journ. Med. Sc., vol. lx. 1870, pp. 43 and 45; Harlan, ibid., p. 47.

Hemorrhage from the pharynx is often from the vessels of the mucous membrane; but in one case, mentioned by Aran, the internal jugular was torn, producing almost instant death. Pharyngeal hemorrhage, or vomiting of blood—this fluid, when retained in the stomach for any time, presenting, when ejected, the appearance of coffee-grounds—is of much less value than either orbital or aural hemorrhage. When profuse, persistent, and the result of violent, diffused force, with accompanying cerebral symptoms, it may prove useful in determining the nature of a doubtful case. Bleeding from the pharynx, or vomiting of blood, may proceed not from fracture of the vault of the pharynx or roof of the nose, but from a fracture of the petrous bone without rupture of the membrana tympani, so that blood entering the tympanic cavity escapes into the pharynx by the Eustachian tube. Dolbeau has pointed out a rarely-observed symptom of fractured base, viz., ecchymosis extending over the posterior pharyngeal wall from the occipital bone to the upper cervical vertebræ. It is most difficult of detection, being generally concealed by the palate.

Bleeding from the ears is the most valuable of the symptoms of fractured base, provided that it be profuse and prolonged, and that a recent rupture of the membrana tympani can be detected. With such conditions after a severe head injury, accompanied by cerebral symptoms, a diagnosis of basal fracture can be safely made; for copious and prolonged hemorrhage indicates a fracture traversing the petrous bone, which has opened one of the larger vascular trunks, as bleeding from those of the mucous membrane would soon spontaneously cease.[1] In one case, already mentioned, from fifty to sixty ounces escaped by the ear in the course of a few hours.[2]

Aran refers to two cases where post-mortem examination demonstrated a tear of the lateral sinus, and other such cases are on record. The flow of blood may continue from two to three or more days.

Hewett reports dissections of thirty-two cases of fracture involving the middle fossa, in fifteen of which there had been a free, steady hemorrhage from the ear. In these the tympanum was traversed by the fracture, and the membrana tympani ruptured. In twelve cases, however, the fracture did not involve the tympanum, and in the remaining five the tympanum was fractured, but the membrana tympani was unruptured. If, therefore, in a suspected case the membrana tympani be found upon examination, to be sound and non-bulging, and to present none of the appearances of blood being effused into the tympanic cavity—that is, change of color of the drumhead by the blood showing through—the fracture, if any exists, can be said not to have involved that portion of the petrous bone in which lie the internal and middle ear, and must involve the apex alone.

Where a fracture of the petrous bone opens one of the large venous sinuses and into the tympanum, as before said, hemorrhage may take place from the nose or mouth, or blood may be vomited. Indeed, this sometimes may occur even with a ruptured membrana tympani. The possibility of this double hemorrhage arising from a fracture of the petrous bone alone, and not from one of the bones forming the roof of the nose or pharynx, must not be forgotten in making the diagnosis, lest greater cranial injury be supposed to exist than in reality has occurred.

Filtration of blood into the cellular tissue of the *occipital region*, or into the subcutaneous tissue of the lateral parts of the *neck*, may take place in basal fracture, producing an appearance as if bruising had there occurred. If it can be proved that the portion of the head struck was far distant from the discoloration, this is a valuable diagnostic sign in conjunction with distinct cerebral symptoms, either precedent or then existing. If no reliable information can be gained as to that part of the head upon which the blow was received, ecchymosis of the regions mentioned can be of no diagnostic value, except—according to Hewett—when a puffiness occurs in the occipital region, with discoloration of the skin a few hours after a severe injury upon this part of the head. He states that this is the result of injury to some of the great venous sinuses and of filtration of the blood between the fragments. I cannot but consider this an eminently uncertain symptom when the occipital region itself has been injured.

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[1] The very exceptional case mentioned by Erichsen, where a blow upon the jaw broke the external auditory meatus, and produced a free flow of blood from the ear, is so unlikely to occur again as not to invalidate the statements which I have made.

[2] Lockwood, Am. Jour. Med. Sc., April, 1859, p. 354.

The *escape of brain-substance*[1] by the ears or nose, of course definitely settles the fact of basal fracture, but is of rare occurrence.

The diagnostic value of *watery discharges from the ear and nose* will be considered hereafter.

Paralysis of the nerves emerging through the various foramina at the base of the skull, especially paralysis of the facial and auditory, has been from time immemorial considered a sign of fractured base. The second, eighth, and ninth pairs are but rarely affected, while the first is not uncommonly injured. Involvement of many nerves, or of those of both sides, is not of much value as evidence of basal fracture, since the symptoms are then probably due to intracranial blood-extravasation.[2] Paralysis of the facial often does not appear immediately after the injury; in fact, in eight out of ten cases reported by Mr. Pick, it only appeared from the second to the sixth day. Owing to the connection of the facial with the spheno-palatine ganglion, it depends on the part of the portio dura injured, whether the uvula and soft palate will be paralyzed as well as the facial muscles, or not. In the former event, the line of fracture must traverse the internal auditory meatus, so as to injure or compress the nerve before it gives off the greater petrosal nerve—that is, between the brain and the geniculate ganglion, which is situated in the first part of the aquæductus Fallopii. If the uvula and palate be unaffected, the line of fracture must traverse the petrous bone so as to injure the facial nerve as it passes in the Fallopian canal across the internal wall of the tympanum.

Diagnosis of Basal Fractures.—The most important diagnostic points have been referred to in considering the symptomatology of basal fractures, but there are some general principles which the surgeon will do well to keep in mind when dealing with a supposed injury of this kind.

Experience has shown that, as a rule, basal fractures result from the application of powerful, diffused force. Thus, in violent blows or falls upon the temporo-parietal region, with marked symptoms of cerebral concussion, we have, according to Aran,[2] from the mere nature of the force, presumptive evidence of a fracture of the middle fossa. While I do not go as far as this author, such a combination of events certainly should suggest the strong possibility of a basal fracture to the surgeon's mind.

In direct fractures, free hemorrhage, or hemorrhage followed by a watery flow, with perhaps symptoms of cerebral compression from intracranial effusion of blood, is apt to occur, and paralysis of one or many of the basal nerves from injury by the vulnerating body. Then, too, an open way having been made to the site of fracture, the finger or the probe will give valuable information.

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[1] Guillemeau, Journ. de Méd. 1779; De Gislain, Annales de Chirurgie, t. viii., p. 229. 1843; Aran, Archives Gén. de Méd., 4e sér., t. vi. p. 329; Lockwood, loc. cit.

[2] Loc. cit.

In fractures by irradiation, that is, those spreading from a fractured vault, there are always marked symptoms of cerebral concussion; usually nasal, aural, pharyngeal, or orbital hemorrhages, according to the region injured; and, if one of the middle fossæ be broken, probably a watery discharge from the ear, either from the outset or following copious and prolonged hemorrhage. Paralysis of one or more cranial nerves—such as the first, if the anterior fossa be involved, or the seventh, if the middle fossa be broken—are also probable symptoms. All these conditions are usually complicated with decided cerebral contusion, which is followed by encephalitis, and the case not unusually terminates in hemiplegia and death by respiratory failure.

(1) *Fractures of the Anterior Fossæ.*—There is usually either a wound or a contusion of the facial or frontal region, with fracture of the frontal bone; prolonged, copious epistaxis, ecchymosis of the eyelids—especially, and first, the lower—with effusion of blood beneath the ocular conjunctiva. Either the olfactory, optic, or third pair of nerves may be paralyzed. Watery nasal discharge may occur. In very exceptional cases cerebral substance may escape by the nares.

(2) *Fractures of the Middle Fossæ.*—There is apt to be a contusion or wound of the middle zone of the cranium, usually in the temporo-parietal region; or a blow across the face or neck may be the cause of fracture. Aural hemorrhage, free and prolonged, usually takes place, followed by watery discharge, and very rarely by an escape of cerebral substance. Paralysis of the facial or auditory, or loss of the function of both of these nerves, probably occurs either primarily, or more commonly within a few days of the injury.

(3) *Fractures of the Posterior Fossæ.*—These fractures ordinarily result from falls upon the occiput, and are often complicated with fractures of the apex of the petrous bone. The symptoms are apt, therefore, to be combined with those of fracture of the middle fossæ. In occipital fractures, severe pharyngeal hemorrhage is more apt to occur than in injuries of other portions of the base, from tearing of the greater vessels which are so closely related to the roof of the pharynx.

Occasionally, as a sequence of fracture of the petrous bone laying open the tympanum, a painless, smooth, circumscribed, elastic, non-fluctuating, resonant tumor forms in the temporal or mastoid region; this is a *pneumatocele.* The air may sometimes be made to escape with a hissing sound. Pressure will cause the total or partial disappearance of the tumor, which at once reappears when the pressure is removed. Usually confined beneath the pericranium, this membrane may give way, when the air becomes more or less diffused throughout the environing connective tissue. Firm pressure is the only appropriate treatment, after a preliminary puncture with a fine trocar. Incision, excision of the sac, and the introduction of a seton, have been followed by serious, if not fatal, symptoms.

Prognosis.—Do basal fractures unite, and what are the chances of recovery? If the patient live long enough, union may undoubtedly occur. There is an admirable specimen of this in the Pennsylvania Hospital Museum,[1] and Mr. Henry Lee gives an account and drawing of another example in the Medical Times and Gazette for 1852. Even months or years after a fracture of the base, no attempt at union may be found, while in other cases the union may be merely by fibrous tissue, or partly a thin plate of bone, partly membrane. In some cases exuberant callus forms, consisting chiefly of porous

[1] There is also a well-marked specimen of a very extensive fracture of the vault and base, in the Wood Museum, Bellevue Hospital, New York. Decided union has taken place, the patient dying long after the injury, from some other affection.

bone, and when the line of fracture has traversed a sinus, this callus may be so excessive as to block up the channel. I have myself seen cases where there was no good reason to doubt that patients had recovered from basal fractures, yet such a result is rare. As I have endeavored to point out, and as Aran has positively stated, since basal fractures are simple linear fissures, with neither displacement nor depression, they, in themselves, add little, if anything, to the danger of the head-injury, if the brain have escaped primary harm. If perfect quiet be not maintained, as in the case of Dr. Wirgman's patient, or as in Mr. Hilton's cases, meningeal irritation and encephalitis will result, but these can often be avoided by rest and appropriate treatment. As an instance of the danger of movement, I may refer to a case of Sir Charles Bell's, in which sudden displacement of a fragment of the occipital bone at the foramen magnum, caused instant death by compression of the spinal cord. And as most basal fractures are complicated with serious intracranial injuries, it has been estimated that 80 per cent. of fatal skull-fractures belong to this variety. Even when apparent recovery has taken place, death often results many months afterwards, from secondary brain-disease.

Treatment.—As these fractures are almost never amenable to operative treatment—and as they depend for their gravity upon the concomitant intracranial injuries—even when their diagnosis is clearly made out, nothing beyond treatment appropriate for expected or present encephalitis should in most instances be resorted to. In some rare cases of injury to the more accessible portions of the base, such as the roof of the orbit or the occipital bone, operative interference has been successfully employed. Occasionally the fragments are depressed, and when this is the case, and they are accessible, they should be elevated. Thus, Hewett has seen a fragment, composing the greater part of the orbit, removed. The trephine has been successfully applied close to the foramen magnum, for a depressed fracture of that region, in a boy aged fourteen years. In this case an incision over an occipital contusion revealed a fissure which, when followed down, led to finding a depressed fragment of bone so firmly impacted as to require the trephine for its removal. Puncture of the membranes was secondarily resorted to for a serous effusion, and recovery took place.[1]

WATERY DISCHARGES FROM THE SKULL.—A discharge of thin, limpid, watery fluid from the ears, nose, or other portions of the skull, is a not unfrequent accompaniment of severe head-injuries, especially of basal fractures. The source of these discharges has been so much discussed, and their importance in the diagnosis of head-injuries has been so variously estimated, that I shall here consider the subject in some detail. Observed as early as 1727,[2] it was reserved for Laugier, in 1839, to demonstrate by dissection that many cases of watery discharge from the ear coexisted with a fracture of the petrous bone and rupture of the membrana tympani. Opinions as to the source of the discharge may be divided, as pointed out by Hewett, into two classes: according to one, the fluid is thought to be nothing but the serum of the blood; according to the other, it is a secretion from some membrane. Laugier first broached the view that the fluid was merely blood-serum from a clot lying in direct contact with the fracture. Afterwards, he taught that the "lacerated vessels lying along the broken bone," with those of the neighboring soft parts, "contributed to the discharge by serous exudation."[3] Chassaignac maintained the untenable view, that, both from the ear and nose, these watery discharges resulted from a filtration of the serum of the blood through the frayed walls of some of the venous sinuses in relation with the fractured bone.

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[1] Med.-Chirurg. Trans., vol. ii. p. 105.

[2] Vander Wiel (Hewett, op. cit., vol. i. page 592).

[3] Archives Générales de Médecine, 4e sér., t. viii. p. 413. Laugier (ibid., p. 386,) declares that he had carefully noted the occurrence of watery aural discharge as far back as 1835.

The membrane of the internal ear, by an increased secretion of the liquor Cotunnii,[1] has been also considered as the source of the discharge, as well as the arachnoid cavity and the subarachnoid spaces.

Examining these views in detail, I would say, in the first place, that the analysis by Chatin[2] proves that the fluid contains only a trace of albumen, and a large quantity of sodium chloride, a fact which I have myself observed. This explodes the blood-serum theory.

When the lines of fracture of the petrous bone do not involve the internal auditory meatus, but the fissure traverses the middle and internal ear, rupturing the membrana tympani and the membranous labyrinth, we certainly cannot affirm that some of the fluid is not liquor Cotunnii, though its large quantity would tend to negative that view.[3] Besides, more than one specimen has been dissected by competent anatomists, where neither fracture existed nor any abnormal communication between the two cavities, and where yet a free aqueous flow took place from the ear. Thus, as one instance:—

A man fell about twenty feet, and striking his head produced a scalp wound, not denuding the bone, at the upper back part of the head. Upon admission to St. George's Hospital there was a discharge of bloody fluid from the ear, which the next morning was roseate, gradually became clear, and was so profuse that two ounces were collected in an hour's time. On the third day it decreased and became purulent. It had been very profuse, soaking the pillow-case so as to require towels to be placed beneath the head. The patient dying upon the seventh day, Sir P. Hewett[4] and Mr. H. Gray repeatedly examined the specimen, but detected neither fracture nor abnormal communication between the middle and internal ear; but the membrane lining the tympanum and mastoid cells was "intensely vascular and covered with muco-purulent secretion, while the membrana tympani was freely ruptured at its anterior inferior part." "The membrane lining the cavities of the internal ear was natural in every respect."

That certain of these free watery discharges really proceed from the subarachnoid spaces—that is, consist of cerebro-spinal fluid—is incontestably proved, by both analysis, dissection, and experiments upon the living patient[5] and upon the cadaver. M. Robert was the first, as far as I am aware, to thoroughly investigate the subject and place it on a firm basis.

To allow the escape of cerebro-spinal fluid through the ear, the fracture must traverse the internal auditory meatus, open into the tympanum, and at the same time tear through the meningeal sheath[6] which incloses the seventh nerve in the auditory meatus, and also rupture the membrana tympani. There is at least one specimen, dissected by Hewett, which proves that the tubular sheath of the arachnoid surrounding the nerves may be torn, coincidently with a line of fracture pursuing the course which I have just described.[1]

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[1] Marjolin, Dict. de Méd., 2e édit., tome xxix. p. 570.

[2] Ibid. Claude Bernard has also shown that both the cerebro-spinal fluid and that poured out in basal fractures often contain a trace of sugar. So little albumen is present that it may not fairly coagulate with heat or nitric acid, but only some cloudiness or opacity be thus produced.

[3] Robert (Archives Générales de Médecine, 4e sér., tome ix.) relates a case where 1000 grammes of fluid were lost by the ear in sixty-six hours.

[4] Op. cit., vol. i. p. 593.

[5] Congestion of the intracranial circulation, effected by pressing upon the jugular veins and closing the mouth and nose with the hand so as to prevent respiration, in the case of a boy with fractured base, produced a marked increase in the flow of watery fluid from the ear (Hilton).

[6] Robert (loc. cit.) says that even a tear of the dura mater lining the internal auditory meatus, at the point where the arachnoid is reflected upon the nerves, will allow the exudation of cerebrospinal fluid.

We thus see that free watery discharge from the ear may coincide with such a fracture as I have described, when it is certainly cerebro-spinal fluid; and that an equally free flow may take place with neither fracture nor injury to the internal ear. Of what value then in diagnosis are these watery ear discharges? Although cases do occur where free watery discharge takes place with neither basal fracture nor injury to the internal ear, yet this symptom is unquestionably of great diagnostic value under certain circumstances.

When the flow is copious from the very outset, having commenced immediately after the accident, and not having been preceded by any hemorrhage from the ear, or by hemorrhage in only very small amount, there is no doubt that it is an outpouring of cerebro-spinal fluid, escaping through a fracture of the petrous bone, traversing the internal auditory meatus, and tearing the infundibular process of the meninges.

Free and prolonged hemorrhage from the ear, succeeded by a watery discharge, is indicative of fracture of the petrous bone; but it does not necessarily follow that the fissure has traversed the internal auditory meatus. And it must be remembered, that, as Sir Prescott Hewett has well said, "it is not to the watery discharge that we can trust for our diagnosis, but to the copious and prolonged bleeding."[2]

When, however, there is at first only a moderate flow of blood, which persists for a short time and is followed by a watery discharge, variable as to time of appearance and amount, the value of the symptom is questionable. The watery flow may appear within a few hours of the injury, and may then rapidly become profuse. As the flow of blood is not enough in itself to be diagnostic, and as some of the facts which I have mentioned go to show that a profuse watery flow may proceed from the ear within a few hours of a head injury without any fracture, we are not warranted in cases of this third class in diagnosing basal fracture merely from the aqueous flow.

The statement that free watery discharges after head-injuries belong to childhood and youth, is unquestionably an error.

Prognosis.—Although often considered to be a fatal symptom, a number of recoveries have been reported; and I have had one case under my own care, of undoubted basal fracture with watery discharge from the ear, where recovery took place. Nevertheless it is a very grave symptom.

Watery discharges from the nose sometimes occur after head-injuries, but rarely as compared to similar flows from the ear.

Blandin first reported a case of this kind in the year 1840, but the source of the flux was not satisfactorily made out. An examination of a case which occurred five years later in the practice of M. Robert, revealed a tear of the dura mater about one inch in length over a fracture of the sella turcica. The visceral arachnoid covering the anterior lobes was also torn. As a proof of the source of the discharge, water dropt into the sella turcica soon filtered through into the nasal cavity, chiefly emerging through the right nostril.[3] Analysis of the fluid composing these nasal discharges proves it to be identical in composition with the cerebro-spinal fluid, and a moment's reflection will show how readily large quantities of this might be poured out from the great sub-arachnoid spaces upon which rest large portions of the base of the brain. Hewett points out that, in addition to this source, another exists in the intra-ventricular fluid, free vent to which would be afforded by a tear of the infundibulum, that is, a part of the floor of the third ventricle. The pituitary gland connected with the infundibulum lies in the sella turcica,[1] which frequently gives way in basal fractures.

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[1] Robert (loc. cit.) records a second case of careful dissection of a fracture of the petrous bone—watery fluid having been discharged by the ear during life—where a tear of the infundibular process of the arachnoid at the bottom of the internal auditory meatus was detected.

[2] Erichsen reports a fracture of the external auditory meatus from a blow on the condyle of the jaw, where many ounces of blood flowed from the ear. This is however very unusual.

[3] Loc. cit., p. 417. M. L. Brown reports in the Boston Med. and Surg. Journal, Dec. 29, 1881, p. 610, an example of watery nasal discharge in a case where, after death, a fracture implicating the cribriform plate of the ethmoid bone was detected.

Strange as at first sight the statement may appear, watery nasal discharges sometimes accompany fractures of the petrous bone, the fluid escaping by the Eustachian tube into the nose from the tympanum, to which the cerebro-spinal fluid has gained access by a fracture implicating the internal auditory meatus.

But what is the diagnostic value of this symptom as indicative of a fractured base? Very little, I think, unless it occur immediately after the injury. Even then there is no certainty about it. If with the small extent of mucous surface of the tympanum and mastoid cells, fluid may be secreted at the rate of two ounces in an hour without any fracture, surely the same is much more likely to occur from the nose. Accordingly, we find that certain individuals are liable to periodical attacks of free discharge of a limpid fluid from the nostrils, which may last for hours.[2] This fact must be borne in mind, lest a clear watery flow from the nose after a head-injury be considered of too great diagnostic value.

In certain cases of compound fracture of the *vault*, where the membranes have been lacerated, a free discharge of the cerebro-spinal fluid takes place.[3] Although in most instances the fluid comes from the sub-arachnoid space, this is not always so. In three cases, one of which has been already quoted in this article,[4] the fluid came from the lateral ventricles. In these cases the flow was very free, and in two of them it came on suddenly at a late period.[5] All proved fatal.

Prognosis of Cases complicated by occurrence of Watery Discharges.—What is the prognostic import of these losses of cerebro-spinal fluid? In themselves, they seem to exert no appreciable effect upon the course of the case, but as they prove an opening into the sub-arachnoid space or into the ventricles, they indicate the existence of visceral lesions which always add to the dangers of any skull-fracture. Where the ventricle is not opened, recovery seems to be the rule. Thus out of eleven cases cited by Hewett, eight ended in recovery, the three fatal cases being those in which the lateral ventricle was laid open.

Treatment.—This must consist in the adoption of appropriate measures, as indicated by the general symptoms. In other words, the case must be treated upon an expectant plan, with no special reference to the escape of fluid.

TRAUMATIC CEPHALHYDROCELE.—Prof. P. S. Conner,[6] of Cincinnati, has collected 19 cases of this rare affection, the list including two reported by himself.

A traumatic cephalhydrocele consists in a subfascial accumulation of fluid, in most instances the result of a simple fracture of the cranial vault. In two cases of gunshot injury, where there had been a communicating wound of the scalp which had closed, and in one case of compound fracture where the external trephine-wound had cicatrized, a similar collection of fluid subsequently occurred. These cases are additional to the 19 already mentioned. There can be no question as to the nature of the fluid, which is most clearly cerebro-spinal; and in three cases a communication with the lateral ventricle has been detected.[1] Where the original injury is not compound, traumatic cephalhydrocele occurs only in the young, 18 cases having been in patients under three years of age, while in one case only (Conner) was the patient 12½ years old. This is explicable, according to Dr. Conner, in part at least, by the yielding character of the skull-bones in the very young, admitting of great depression and fissuring of the vault, without associated wound of the scalp.

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[1] In Blandin's case, before mentioned, this accident probably occurred. (Reported by Demarquay, Gaz. des Hôpitaux, p. 205. 1840.)

[2] See Hewett, op. cit., vol. i. p. 596.

[3] Dudley, after trephining for epilepsy, found a bony spicule which pressed on the dura mater; the next day fluid commenced to flow and continued to do so for eight days, recovery ensuing. (Am. Jour. Med. Sciences, 1828.) O'Halloran (Dub. Med. Press, vol. xiii. p. 81), and Hey, of Leeds (Practical Observations in Surgery, p. 21), also report instances of watery flow from the vault after fracture.

[4] Bouchacourt, Bull. de la Soc. Anat. de Paris, tome xiii. p. 13.

[5] Erichsen, op. cit.; also Hewett, op. cit., vol. i. p. 597.

[6] Proceedings of American Surgical Association, 1884.

Symptoms.—Traumatic cephalhydrocele may appear at once after the injury, or not until the expiration of four months, and a positive diagnosis is often impossible without a withdrawal and examination of the contents of the swelling. A typical case presents a soft, compressible tumor, covered by normally colored, distended integuments, so thin, perhaps, as to be translucent. In more than one-half of the cases, pulsation was apparently not observed.

When this symptom is present, with those already described; when pressure diminishes the bulk, with or without evidences of cerebral irritation; when the tension of the swelling is increased by crying or holding the breath; and when the condition noted has followed a simple fracture of the vault, the *diagnosis* is clear. When, however, there is neither pulsation, translucency, nor evidence of fracture, if appearing early, the condition will probably be mistaken for a hæmatoma, or, when coming on long after the injury, for a deep-seated abscess. Under such circumstances an examination of the fluid can alone determine the nature of the swelling, and an exploratory aspiration is therefore indicated in doubtful cases.

Prognosis.—The mortality of traumatic cephalhydrocele depending upon simple fracture, Dr. Conner shows to have been 50 per cent., death in fatal cases having resulted from encephalitis; while when the disease has followed compound fracture, one-third of the patients have died, from cerebral abscess. Recovery, when it does ensue, is followed, in many cases, by a morbid mental state, irritability of temper, etc. Though complete consolidation of the fracture, with consequent abolition of the communication between the intracranial and extracranial cavities, may occur, it is, according to Dr. Conner, very unlikely to take place in any case in which the opening has been large and the subaponeurotic accumulation great.

Treatment.—Nothing beyond aspiration or tapping with a fine trocar is admissible, and this only when symptoms of intracranial pressure, such as squinting, pain, or "decided symptoms of distension of the nasal or orbital lymph spaces," are noted. The sac should not be completely emptied, lest cerebral irritation result, as actually occurred in one of Dr. Conner's cases, when pain in the forehead and side of the head compelled him to discontinue the operation. Moderate—but only moderate—pressure may, perhaps, lessen the rapidity and extent of the distension. The following conclusions are drawn by Dr. Conner, as the result of his researches and experience.

1. Simple fracture of the vault of the skull may give rise to a collection under the scalp of the cerebro-spinal fluid; coming, it may be, only from an opened ventricular cavity.
2. Such traumatic cephalhydrocele may be developed quickly, or only after the lapse of a number of days or even weeks.

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[1] Guy's Hosp. Reports, 3d series, vol. xxv. p. 91. Archiv f. klin. Chir., Bd. iii. S. 398; Jahrbuch f. Kinderheilkunde, Bd. xviii. S. 367. (Conner.)

3. The condition is one that has thus far been noticed only in young subjects.

4. The accident is quite likely to prove fatal from lepto-meningitis or meningo-encephalitis.

5. Operative interference should be restricted to the removal by aspiration of a limited amount of fluid; and such aspiration should be made only when severe pressure-symptoms have manifested themselves.

6. A similar fluid accumulation may occur after closure of the external wound of a compound vault-fracture or of a trephining.

SEPARATION OF SUTURES.—When occurring in the cranial vault, these accidents are, as a rule, restricted to the young, in whom the skull-bones have not as yet become co-ossified.[1] In later life, force applied at the site of an obliterated suture may cause a fracture which accurately follows the old sutural line, as in a case recorded by Prof. Agnew.[2] In the Wood Museum, New York, is a specimen (uncatalogued) where the line of fracture has passed exactly through the obliterated interfrontal suture. The injury resulted from diffused force, that is, a blow from a sand-bag. A musket-ball may, according to Guthrie, produce separation of a suture of the cranial vault, by impinging directly upon it with a moderate degree of force, although "in general it takes place when the ball happens to lodge, as it were, between the bones concerned in the formation of the suture." Guthrie[3] reports one case where separation of the sagittal suture was caused by a fall upon the vertex, the patient dropping from his saddle with a bullet-wound of the thorax. In basal fractures of the skull, the sutures of other parts are not uncommonly separated. In fourteen cases of fracture accompanied by separation of sutures, examined by Hewett, the coronal suture was separated in seven cases, the lambdoid in six, the sagittal in four, the petro-occipital in one, the temporo-parietal in one, and the spheno-parietal in one. Referring to the great rarity of such accidents, he remarks that he has never seen but one example uncomplicated with fracture. In this case the temporal bone was slightly separated and driven upwards at the back part of the squamoso-temporal suture, closely simulating a fracture with depression.[4] I have lately seen a case where the squamoso-parietal suture was slightly separated by a blow upon the parietal, which must have been slightly depressed, as the squamous plate was at one point about a line above the parietal bone. The sagittal (twelve times) and the masto-occipital suture (seven times) have been those most commonly separated in the twenty-one specimens of fracture with sutural separation which I have examined. Where a number of sutures have been loosened, a whole bone, as for instance the frontal, may become almost detached from those around it.

Prognosis.—Separation of sutures is most frequently effected by the application of great force, such as firm compression of the head between two hard, resisting bodies, falls from a great height, or the impact of a spent cannon ball. In consequence, the prognosis is very bad,[5] for the bone-injury is frequently complicated by extensive pericranial laceration, or by separation of the dura mater, while at times both these membranes are freely torn, with laceration and extrusion of the brain-substance, which, under such circumstances, may be found just beneath the integuments. This, however, is not always the case: in an extensive cranial fracture reported by Hewett, the parietals were widely separated, and at a different level along the whole extent of the sagittal suture, the depression of the right bone being fully two lines below the cranial surface; yet the brain itself was totally uninjured.[1] Separation of the sagittal suture has, in several recorded instances, resulted in extensive intracranial extravasation of blood, requiring the use of the trephine upon one or both sides of the median line. In one instance this condition was indicated by the presence of coma, with "a longitudinal elevation extending the whole length of the sagittal suture;"[2] when incised, this gave vent to liquid blood and revealed a sutural separation. Subsequently the trephine was applied upon either side of the median line, evacuating much blood, and resulting in the cure of the patient.

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[1] Morgagni, however, reports a case in a man sixty years old.

[2] Principles and Practice of Surgery, vol. i. p. 274.

[3] Commentaries on the Surgery of War, 6th ed., p. 349.

[4] Hewett, op. cit., vol. i. p. 591.

[5] Larrey (op. cit., p. 317) reports a case of recovery after separation of the coronal suture, death taking place from independent disease, six months afterwards.

Treatment.—This is essentially that of fracture of the skull, except when the injury causes intracranial hemorrhage, when the treatment is that which has just been indicated in relating M. Mouton's case.

All compound fractures of the skull, whether operated upon or not, should be thoroughly irrigated with the corrosive sublimate, carbolic acid, or some other antiseptic solution, and then carefully dressed with sublimate gauze, a full Listerian dressing, or, in default of these, with any other antiseptic dressing that the circumstances may admit of.

INJURIES OF THE MENINGES AND BRAIN.

INTRACRANIAL EXTRAVASATIONS OF BLOOD.—Blood may be effused (1) between the dura mater and the skull; (2) in the cavity of the arachnoid; (3) on the surface of the brain—that is, in the meshes of the pia mater; (4) in the cerebral substance; and (5) in the ventricles of the brain. Although these collections may occur without fracture, they are much more commonly concomitants of such an injury.

(1) *Extravasation between the Dura Mater and the Skull.*—The sources of the hemorrhage are threefold, viz: (1) the small vessels passing from the membrane to the bone; (2) the middle meningeal artery; and (3) the venous sinuses of the brain. Extravasations from the first source are usually very limited, and have been mentioned in connection with bone contusion; the effusions which come from ruptures of the meningeal artery or its branches are by far the most common, for "out of thirty-one cases of fracture of the skull, accompanied by extravasation," . . . . the hemorrhage proceeded "from the middle meningeal artery in twenty-seven cases."[3] Extravasation due to rupture of one of the sinuses is the least common variety, but when it does occur may be very extensive, as in a case reported by Hewett, in which the lateral sinus was torn, "just as it turns under the petrous portion of the temporal bone."[4]

The anterior branch of the middle meningeal artery is usually said to have been ruptured at the anterior inferior angle of the parietal bone. A moment's consideration of the course pursued by the artery, after its entrance through the foramen spinosum, will show that in the most common variety of basal fracture of the skull, viz., that which involves the middle fossa, the vessel may be torn at any point from its entrance into the skull up to the anterior inferior parietal angle. The artery, in addition, frequently divides into two branches of nearly equal size, soon after its entrance into the skull.

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[1] Hewett, op. cit., vol. i. p. 592.

[2] Mouton (Quesnay, Memoirs of the Royal Academy of Surgery, translated by Ottley, p. 8).

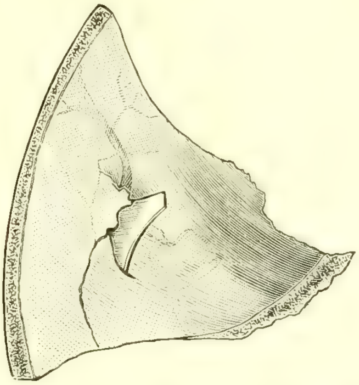
[3] Holmes's System of Surgery, 3d ed., vol. i. p. 575.

[4] It has been demonstrated by experiment, that a clot between the dura mater and bone, equalling one-twelfth the capacity of the cranium, will produce coma and death within a few hours.

The anterior division proceeds to the anterior inferior angle of the parietal bone,[1] while the other branch, passing much more posteriorly, ramifies over the whole of the parietal, and also sends branches to the contiguous portions of the frontal and occipital bones. From these anatomical considerations, it will be seen that extensive extravasations of blood may arise from rupture of the middle meningeal artery, from lines of fracture which do not involve the anterior inferior angle of the parietal, but which run across some of the large branches just mentioned. From whatever source proceeding, the hemorrhage is large in amount from the extensive, coexistent separation of the dura mater.[2] The clot forms a "hard, granular mass, breaking down with great difficulty, even under heavy pressure, and adhering most firmly to the parts between which it is lying." The subjacent brain itself, in a large extravasation, is depressed in a cup-like manner, and the convolutions of the brain are apparently flattened. The statement that hemorrhage from laceration of the great meningeal artery may cease from compression by the resultant clot, after a small effusion of blood, is probably purely theoretical.[3] If the patient survives, the clot becomes decolorized and absorbed, to judge from the appearances presented by one case reported.[4] Punctured wounds, as from a penknife blade or fragment of glass, have been reported, where death resulted from extensive effusion due to a division of one of the large meningeal branches.[5]

Symptoms.—These are very variable, being dependent upon the greater or less rapidity of the sanguineous effusion, and are, in brief, those of compression. With marked collapse and consequent feeble circulation—perhaps from the small size of the effusion—the ordinary phenomena may be delayed for hours, even days. The symptoms differ from those consequent upon depression of bone, or the pressure of a foreign body, in not being immediate. Thus, after a blow upon the head, the ordinary phenomena of concussion are observed. With the feeble circulation the effusion is very slight, but, as reaction takes place, the blood rapidly collects between the dura mater and the bone. The patient usually regains complete consciousness, but the symptoms of concussion may, in some instances, become so merged with those of compression, that a differential diagnosis between compression from depressed bone, subcranial hemorrhage, and contusion of the brain, is impossible. (In such cases, the elevation of depressed fragments often gives vent to extravasated blood, which is then seen to have been the cause of the symptoms of compression, rather than the displaced bone.) Soon, generally within half an hour—although, when the flow is gradual, the brain accommodates itself to the pressure, so that many

Fig. 829.



Punctured fracture of skull by a piece of glass, with wound of middle meningeal artery. (From a specimen belonging to Prof. Conner, of Cincinnati.)

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[1] The groove in which the vessel lies is often converted into a bony canal, thus rendering rupture of the artery almost certain when this portion of the bone is broken.

[2] Although the primary separation effected by the blood is the chief factor in this condition, yet a collection of fluid blood, once formed between the dura mater and the bone, and communicating with an open artery, must, upon well-known hydrostatic principles, tend to extend, and to dissect off the membrane still further until clotting occurs.

[3] S. W. Gross reports two cases, in private practice, with large clots, where the blood flowed freely from the trephine holes, despite the clots.

[4] Hewett, op. cit.

[5] Conner, Cincinnati Lancet and Clinic, Jan. 5, 1884.

hours or days may elapse—the patient becomes unconscious; the respiration, at first laborious, usually becomes stertorous, while, at times, there is a peculiar whiff at the corners of the mouth; the pupils are either contracted or dilated—generally the latter—or one is dilated and the other contracted, but in any event insensible, or nearly so, to light; the pulse is full and slow; and there is paralysis, more or less complete, of the side opposite to the effusion, with diminution of its temperature. In addition, there may be retention of urine and involuntary discharge of feces. An epileptiform convulsion, after the interval of consciousness, may usher in the symptoms of compression. Prof. S. W. Gross reports the following instructive case:—

> A young soldier was struck senseless by a piece of shell, but soon recovered, vomited, and, although obliged to rest frequently, walked to the rear, a distance of nearly three miles. He appeared drowsy and unwilling to move, after each stoppage. He was perfectly rational, was restless during the early part of the night, moaning so as to disturb his companion, but at the latter's request keeping quiet, and in the morning seemed in a profound sleep. His comrade failing to rouse him, Dr. Gross was called, and found him in a state of profound coma, with a slow, stertorous, puffing respiration. The pulse was eighty-four, small and feeble; the "pupils dilated—the left nearly to its utmost extent—and completely insensible to light." Slight left hemiplegia was noted, with contraction of the flexors of both arms. "The left leg was firmly extended, powerless, and not so sensible to external impressions as the right, which was in the same condition, but to a less degree." There was a lacerated scalp-wound, just below the right parietal eminence, without fracture. Death ensued after five hours, and, upon opening the skull, an enormous clot was found between the left parietal bone and the dura mater, completely filling the middle fossa of the skull, and thus compressing the left third nerve at the sphenoidal fissure. A linear fracture passed through the left spheno-parietal suture, dividing the bony canal inclosing the middle meningeal artery, which was torn. Corresponding to the site of the contused but unbroken bone, the brain was ecchymotic, and contained a small clot, "the size of a hazel-nut."[1]

This case teaches two important lessons, viz., that the effusion of blood may take place upon the side opposite[2] to that of injury; and that rupture of the meningeal artery is apt to be complicated with contusion of the brain.[3] An explanation is also afforded of the condition of the pupils. When the third nerve upon one side only is compressed, the pupil of that side will be dilated, while if the nerves of both sides are pressed upon, both pupils will be dilated. It is probable that where one pupil is dilated and the other really contracted—not merely in its normal condition—the nerve upon the side of dilatation is so compressed as to have its function abolished, while upon the side of contraction the effusion has simply irritated the nerve and exalted its function. I dwell upon these minuter points because of the marked obscurity in the diagnosis of the injuries now under consideration. If the corpora quadrigemina be either compressed or much lacerated, dilatation of the pupil occurs; a fact which must not be lost sight of, lest a severe contusion or laceration of the brain be overlooked. In exceptional cases there may be no loss of consciousness, and this condition may persist until shortly before death. The hemiplegia may also be imperfect, or may even be transient, with so large an effusion as three ounces poured out in the sphenoidal fossa.[4] With large effusions there may be no stertor; the pupils may be normal or nearly so; the pulse may be soft, compressible, frequent, or irregular; and paralysis may be absent or incomplete.

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[1] Loc. cit., p. 45.

[2] Erichsen reports a similar case. (Op. cit., vol. i. p. 555.)

[3] In twenty-five cases of large extravasations of blood between the bone and dura mater, observed at St. George's Hospital, the brain was more or less extensively lacerated in every one. Hewett, op. cit., vol. i. p. 576.

[4] Hutchinson, London Hospital Reports, vol. iv. p. 44.

Diagnosis.—It is important to note, first, that Duret has shown that, owing to the dura mater being freely supplied with sensory nerves mainly springing from the fifth pair, certain symptoms are occasionally present when this membrane is irritated, which are also those of lesions of the brain-substance. As a guide in the differential diagnosis, I would, after Stimson and Duret, give the following points:—

A slight injury of the brain-cortex will probably evidence itself, primarily, by exaggerated functional activity of the part, viz., muscular twitching, while from a destructive lesion, paralysis will result, and in both cases the abnormal symptoms will be on the side opposite to that of injury. Lesions of the dura mater are more apt to produce spasms and contractures of the voluntary muscles on the side of injury; "they tend to become more or less generalized, and involve the neighboring muscular groups; and never have the localization and voluntary appearance of contractions induced by lesions of the cortex;" finally, paralysis never occurs.

From the frequent coexistence of contusion and laceration of the brain,[1] which, as we shall see, present symptoms closely simulating those of large subcranial effusions, a positive diagnosis is often impossible, especially in the exceptional cases just described. When, however, a patient receives a blow upon the head which stuns him, recovers consciousness for a variable but distinct interval, then becomes gradually comatose, and has opposite hemiplegia, with dilated pupil and diminished temperature of the paralyzed side, the diagnosis is easy. Sir Prescott Hewett relates the following typical case:—

A man came to St. George's Hospital a few minutes after having been struck with a spade just over the anterior inferior angle of the parietal. A compound fracture with depression of a small piece of the skull was detected, with an entire absence of cerebral symptoms. In a short time, however, "the patient became heavy and stupid, and coma was gradually supervening, when Mr. Keate arrived and at once proceeded to remove the depressed bone; whereupon a jet of blood spirted from a large branch of the middle meningeal artery, all the symptoms of compression were immediately relieved, and the patient recovered."[2]

In every case of this kind, however obscure, if a distinct history of an interval of immunity from cerebral symptoms is obtained after a head injury, the presumption is that at least subcranial hemorrhage is present. If with this, one pupil is dilated, and we have a bruise, or even the history of a blow upon that side of the skull, the presumption almost amounts to a certainty. If now there are symptoms indicating involvement of the whole or a part of the motor area of the side of injury, with dilated pupil,[3] we are warranted in affirming that there is an intracranial effusion of blood whose site we can define with reasonable accuracy, provided that there is an entire absence of the symptoms of brain contusion, such as tonic spasm of the muscles, extreme restlessness, etc.[4] The symptoms of concussion are immediate and transient, and therefore cannot be confounded with those of effusion of blood. Compression symptoms after a depressed fracture will be immediate, if due to the displaced bone; if of later development, they are probably due to effused blood. When the compression symptoms come on very soon after the injury, there is either extensive detachment of the dura mater, or some of the large meningeal branches have given way, or both conditions coexist. When a meningeal branch is the source of the effusion, the clot is likely to be located at the side and base of the brain. Unless the shock and collapse are exceptionally prolonged, when the force of the circulation will not suffice to dislodge the clots in the torn vessels and overcome the resistance of the inverted vascular tunics, the delay of hours or days in the appearance of compression symptoms indicates a limited separation of the dura mater, and shows that the source of the hemorrhage is rather from the dural vessels than from the meningeal artery. Alcoholism may be differentiated by the thermometer, the temperature being markedly subnormal,[1] and by the flushed, turgid face, instead of the pallor which attends severe injury. Drunken men with head injuries should be carefully watched until sufficient time has elapsed for recovery from intoxication, as there may be concomitant cerebral injury which otherwise might escape detection. Apoplexy, causing a fall, with a consequent scalp wound or cranial fracture, is a condition which would be impossible of recognition without the testimony of some eye-witness as to the fall having been produced by some precedent head trouble. In opium poisoning, the pupils are both contracted to the size of a pin-point instead of being widely dilated, or one being dilated and the other only moderately contracted.

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[1] Erichsen (op. cit., vol. i. p. 555) reports two cases where ruptures of the meningeal artery resulted from most trivial injuries.

[2] Hewett, op. cit., vol. i. p. 576.

[3] See section on cerebral localization.

[4] I am aware that many cases of brain contusion fail to give any such immediate or remote symptoms, but certainly when these symptoms are present, post-mortem examination will reveal contusion of the brain. When such symptoms are present, the accuracy of any diagnosis of intracranial extravasation of blood is more than questionable.

Treatment.—To be of any avail, this must effect the removal of the blood already effused, and the prevention of further hemorrhage. The aid of the facts of cerebral localization must be invoked, together with a knowledge of the anatomical course of the two main divisions of the great meningeal artery. If the symptoms rapidly supervene, an opening at either the anterior inferior or the posterior inferior angle of the parietal bone, will probably reveal the source of hemorrhage, unless cerebral topography indicates some other point for the application of the trephine. When found, the injured vessel may be secured by plugging its bony canal with the point of a sharpened match, with a pellet of wax, or with a red-hot knitting needle. Early operation is indicated, since it affords the best prospect of success, as shown by results. Thus out of forty cases which I have collected in which operations have been performed under these circumstances, twenty-four have ended in recovery and sixteen in death.[2] Twenty-two were primary operations, of which number eight were fatal; two operations which were successful, were probably early, but I cannot ascertain the details; while of sixteen secondary cases, only one-half recovered. Several of the successful cases occurred within the past twenty years, thus refuting Mr. Hutchinson's statement that no modern instances of success are on record. The cause of death is usually suppurative encephalitis. If the dura mater does not rise up to the cranial level, the prognosis is bad, the dural depression probably indicating extensive injury of the subjacent brain substance. The trephine should be of large size, and should fluid blood issue from the first opening, and the source of hemorrhage not be detectable, one or more openings should be made along the course of the meningeal artery until the bleeding point can be reached. According to a statement in Dr. Keen's edition of Mr. Holden's "Landmarks," the vessel will be uncovered by a trephine applied with its centre-pin about an inch and a half behind the external angular process of the frontal bone, and the same distance above the zygoma. A number of the cases above referred to, were instances of depressed gunshot fracture from non-penetrating projectiles; they are particularly instructive as giving the results of treatment of ruptured intracranial vessels, as nearly uncomplicated with cerebral injury as it is possible to conceive. Where an operation appears contraindicated, perfect quietude, cold to the head, purgatives, perhaps blood-letting, certainly an antiphlogistic diet, and the constitutional effect of mercury, should be tried. At a later stage of the case, iodide of potassium is indicated. I fear, however, that only a mistaken diagnosis will ever give time for such treatment, and that when cases of supposed marked extravasation between the dura mater and skull end in recovery, some other condition will have really existed.

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[1] Agnew (op. cit., vol. i. p. 285) quotes Dr. B. W. Richardson to this effect.

[2] S. W. Gross, fourteen cases (Am. Journal of the Med. Sciences, New Series, vol. lxvi. p. 45); Mouton, Dru, and Pineau (Quesnay, Memoirs of the Royal Academy of Surgery, Trans. by Ottley, pp. 8, 12, 14); Physick (Gross, System of Surgery, 6th ed., vol. ii. p. 55); Conner (Cincinnati Lancet and Clinic, Jan. 5, 1884); Hennen (Military Surgery, Case XLIX.); Guthrie (Commentaries on the Surgery of War, 6th ed., p. 349); Keate (Holmes's System of Surgery, 3d ed., vol. i. p. 576); Tatem (ibid.); S. D. Gross (op. cit., vol. ii. p. 55); Erichsen (op. cit., vol. i. 556); Larrey (Mil. Surg., vol. i. p. 306); Guthrie (Commentaries, pp. 315, 316), etc.

(2) *Hemorrhage into the Cavity of the Arachnoid.*—This is the most common site for traumatic extravasations of blood, which is found in the arachnoid cavity not only in the majority of severe head injuries, but "also in cases where the injury has been a trifling one, and that without any apparent lesion either about the brain or its membranes."[1] The sources of the hemorrhage are the vessels of the pia mater, with tearing of the visceral arachnoid; the superficial cerebral veins; and the great sinuses; and this form of extravasation may even coexist with effusion of blood from vessels between the dura mater and skull, the blood finding its way into the arachnoid cavity by a rent of the former membrane. In most instances the situation of the blood corresponds to the cerebrum, sometimes to the cerebellum, and very rarely to the medulla oblongata. Blood thus effused undergoes certain important changes, to which I would here call attention.[2] At first after coagulation, the blood forms a membrane-like expansion which is accurately moulded by the parts between which it lies. When in large quantity it may cap both cerebral hemispheres. In time the coloring matter of the blood more or less disappears, when the decolorized clots present the appearance of membranes of varying hues, such as are found in the arachnoid cavity after head injuries, and were formerly erroneously considered to be of inflammatory origin.

"In slight extravasations" only a mere film is found after the lapse of a few days, "so delicate and so slightly tinged as easily to escape notice." In most cases these false membranes are firmly attached to the parietal arachnoid, present a smooth, polished, serous-like surface, and are throughout supplied with numerous vessels, which are often detectable by the naked eye. Even as early as the twenty-third day, these characteristic appearances may be well marked.

At first "soft and pulpy," these membranes may subsequently become "leathery, fibrous, or even cartilaginous."[3] Owing to the serous-like covering that these effusions early become coated with, there is a most deceptive appearance of the hemorrhage having been between the parietal arachnoid and the dura mater, thus stripping off the former. It has been only of late years that the French pathologists have pointed out the true nature of these appearances. Doubtless the organization of these clots is effected after the manner of those found after the ligation of arteries, so ably investigated by Rindfleisch and by E. O. Shakespeare. When the effusion is large, instead of false membranes we may have true cysts formed, either single or multilocular, containing anything from the variously decolorized remains of the original clot, up to what appears to be pure serum. Recent clots may also be found, due to rupture of the newly formed vessels of the cyst. These cysts may contract more or less perfect adhesions to both layers of the arachnoid, but usually are firmly attached to the parietal arachnoid alone. They are more rarely found either attached to the parietal layer by a few filaments, or perfectly free in the arachnoid sac. They may be of large size, as one reported by Dr. Quain, which was seven and a half inches long and one and a half inches wide at its broadest part. The cyst had formed a corresponding depression upon the upper surface of the cerebral hemisphere.[1] Not confined to any age, these cysts when large compress and flatten the subjacent convolutions, and contract the area of the corresponding ventricle. If formed in early childhood, they have been known to produce bulging outward of the cranial bones.[2]

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[1] Hewett, op. cit., vol. i. p. 576.

[2] To Sir Prescott Hewett's article On the Extravasation of Blood into the Cavity of the Arachnoid (Med.-Chirurgical Trans., vol. xxviii.), and to the same author's article on Injuries of the Head, in Mr. Holmes's System of Surgery, I am largely indebted, and would here once for all acknowledge the fact.

[3] This refers merely to their *physical*, not to their *histological* appearances.

Virchow has pointed out that some intra-arachnoid blood-cysts have their origin in ruptures of bloodvessels in newly-organized inflammatory false membranes.

Symptoms.—These are not characteristic when the effusion is small, and even when large it may produce no very decided evidences of compression. The signs are apt to be masked by those of cerebral laceration, a common accompaniment of intra-arachnoid extravasation. Da Costa gives the symptoms as "ordinarily pain in the head, somnolency, and profound coma with paralysis, and without anæsthesia or slow pulse, but with relaxation of the muscles, and sometimes . . . convulsions." When circumscribed or limited to one hemisphere, the symptoms are identical with those presented by effusions between the bone and dura mater. In most cases there is an interval of consciousness after the shock has been recovered from. When this is not so, there is probably extensive laceration of the brain, and the pulse is more apt to be rapid, small, and feeble, rather than slow, full, and labored. The respirations are, according to S. W. Gross, rather labored than stertorous. Marked inequality of the pupils is rare, and the hemiplegia is not as decided as in subcranial effusion.

Diagnosis.—A differential diagnosis can, under the most favorable circumstances, be only probable, and in most instances it is impossible.

According to S. D. Gross, infants, "before the completion of the ossific process," suffer from intra-arachnoid effusion of blood, the results of blows upon the head. The "little patient lies in a state of insensibility, and is usually affected with convulsions, or spasmodic twitches, and perhaps some degree of stertor." The scalp is commonly severely contused, but owing to the yielding nature of the bones, no fracture exists. The fontanelle appears to be elevated somewhat above its proper level, while pressure detects increased tension, and may increase all the symptoms, especially the tendency to convulsions.

The *prognosis* is bad,[3] for, even should recovery ensue, constant headache, irritability of temper, epilepsy, or insanity, may result.[4]

Treatment.—In most cases this must be that of other severe injuries of the head—the use of local cold, blood-letting, mercurials, and the iodide and bromide of potassium, as may seem indicated. In a few rare instances, where, owing to circumscription of the effusion, the symptoms resemble those of effusion between the dura mater and the bone, trephining may be resorted to, and the operation has been successful in a few such cases. After the disk of bone has been removed, the dura mater bulges into the opening, is of a bluish appearance, and is devoid of pulsation. The membrane should then be incised to give free vent to the effused blood.[1] In at least two reported cases, this bulging of the dura mater did not take place for hours—in one case thirty-six[2]—after the trephining. In the cases which occur during infancy, the elder Gross recommends leeching and cold to the head, stimulating enemata, and brisk purgatives when the child regains the power of swallowing. Failing by these means to afford relief, he advises making a crucial incision over the fontanelle, and puncturing the "distended, and perhaps purple-looking membrane," making as small an aperture as will suffice to effect the purpose in view, after which a careful application of adhesive strips, compresses, and roller bandages must be made. In conclusion, as to operative measures, recognizing as I do the extreme difficulties presented by the diagnosis, and the small percentage of success attendant upon operative procedures in intracranial extravasations of blood, I think that three facts cannot be denied, viz., that in a certain proportion of cases life has been saved by trephining; that post-mortem records show that a number of patients have perished from intracranial extravasation of blood, who could probably have been saved by timely operation; and that trephining in such cases, though it fail to afford relief, cannot be said to measurably reduce the chance of recovery. I cannot but feel that too many cases are allowed to pass without operation, some few of which might be rescued if the surgeon were not deterred—as is too often the case—rather by considerations of what will be said if an unnecessary operation be performed, than by sound surgical contra-indications. Practically, every case which recovers after the removal of extensive intracranial blood-effusion, may be considered as one which otherwise would have died, as clinical records show that such cases almost never terminate favorably.

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[1] Trans. Path. Soc. Lond., vol. vi. p. 8.

[2] Lancet, vol. i. p. 416. 1846.

[3] An effusion equal in bulk to one-sixth or even one-fifth of the cranial capacity seems necessary, of itself, to produce death.

[4] Dict. de Méd. et de Chir. prat., t. xi. p. 407; Blandin, Anat. topographique, 2me éd., p. 36. 1834; Holmes's System of Surgery, 3d ed., vol. i. p. 579.

(3) *Hemorrhage into the Pia Mater.*—These extravasations occur much more rarely than those of the preceding variety, and are usually accompanied by some degree of cerebral laceration. Confined beneath the arachnoid, they spread far from their original source, until even the whole cerebellum and spinal marrow may thus be covered with blood proceeding from a laceration of the cerebrum only. Effusions of blood into the pia mater never become encysted, as far as I can ascertain.

Symptoms.—This condition presents no symptoms, at present known, which can be relied upon. In most cases of hemorrhage upon the surface of the brain, the patients are said to have been comatose, and to have given no evidence of partial paralysis.

Treatment.—As operative interference is out of the question, from the impossibility of removing the blood already poured out, or, even if that could be done, of preventing further effusion, such remedies as are appropriate for other severe head injuries should be resorted to.

(4) and (5) *Hemorrhage into the Brain and Ventricles.*—Large effusions into the structure of the brain may result from severe head injuries, as well as hemorrhage into the cerebral ventricles. Caution must be exercised lest cases of apoplexy from diseased vessels, either producing the fall which appears to be the cause of the head symptoms, or rendering possible a large effusion from a slight injury, should be confounded with traumatic hemorrhage in either of the situations just mentioned. Should the patient survive long enough, an unusual event from the severity of the concomitant intracranial lesions, the effused blood undergoes the well-known changes of a simple apoplectic effusion.

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[1] Successful cases are reported by Morand (Opuscules de Chir., tome i. p. 171. Paris, 1768), Ogle (Brodie, Med.-Chir. Trans., vol. xiv. p. 391), and others. Three cases are given in Bruns's Handbuch der praktischen Chirurgie, Abth. i. S. 931. (Gross.)

[2] Agnew, op. cit., vol. i. p. 286.

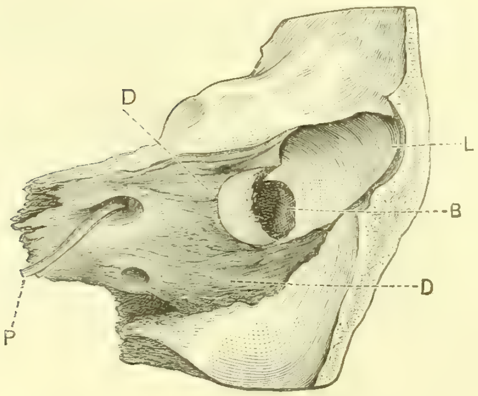
Symptoms.—These are essentially those of apoplexy, such as marked coma, etc., with perhaps convulsions in a few cases.

Treatment.—This, as in apoplexy, must be purely medical, and need hardly be further enlarged upon.

WOUNDS AND RUPTURES OF THE GREAT VENOUS SINUSES.—Those most commonly injured are the superior longitudinal and lateral sinuses. The mere shock of a violent blow upon the cranium may lacerate these vessels, but they are more frequently ruptured by separation of sutures. Penetration by the fragment of a depressed, comminuted fracture is the usual cause of wounds of the great sinuses, but penetrating wounds of the skull by pointed instruments or bullets may also injure these venous channels. I am led to thus specially treat of these injuries, on account of the general impression that the hemorrhage following them is usually fatal. So far is this from being true, that Pott actually bled successfully from the longitudinal sinus. Warner, Pott, and Lister, report cases where wound of this sinus was readily recovered from. In all such cases, either the application of the trephine or the elevation of fragments has given free access to the wounded vessel. Where the opposite conditions obtain, a fatal hemorrhage does at times occur. I am cognizant of one case where a prominent surgeon, while operating for a comminuted depressed fracture of the occipital bone, withdrew a pointed fragment which had been driven some distance beneath the sound skull, thus plugging a distant wound of the lateral sinus. Death resulted in a few minutes from the uncontrollable hemorrhage. I have examined the specimens from a fracture of the vertex, where the patient similarly perished upon the withdrawal of a depressed fragment. In basal fractures the hemorrhage from rupture of the sinuses may be very profuse. Thus in one case reported, it was estimated that between thirty and forty ounces were lost from the ear in the course of a few hours.

Treatment.—Where this injury is suspected in a case of compound fracture, from the propinquity of the lesion to the course of a great sinus, I would suggest that the trephine-cut, or removal of bone necessary to elevate the fragments, be so planned as to give free access to the sinus should it be found wounded. This can usually be safely done, for the injury will have probably separated and depressed the dura mater so as to keep it clear from the teeth of the instrument. In nearly all the cases where the wound has been accessible, the application of a little dry lint, with the pressure of the finger, has at once arrested the flow. Lister filled an opening in the longitudinal sinus with a bunch of catgut ligature, and J. H. Brinton seized the lips of a wound of the lateral sinus with forceps, and tied it with fine silk. The only wound of a sinus which has occurred in my own practice, was that of the right lateral sinus, from a small pistol-ball. I suspected it from the history of a free flow of blood,

Fig. 830.



B, opening made by ball in bony and membranous wall of lateral sinus ; DD, portions of dura mater and sinus walls ; L, lateral sinus with portion of its membranous wall removed ; P, portio dura and portio mollis of seventh nerve.

and from the course pursued by the ball through the mastoid process. No further hemorrhage took place, the ball was supposed to have penetrated the brain deeply, and the patient died of pyæmia. Post-mortem examination revealed that the missile had just penetrated the sinus, and had plugged the opening, which finally became so enlarged by ulceration as to permit the ball to fall into the lumen of the sinus, out of which it rolled when the vessel was opened. Although not recommending such a procedure when it is avoidable, the ease with which hemorrhage from these venous channels can be arrested, proves that, as far as bleeding goes, trephining can be safely performed over the course of either the longitudinal or the lateral sinus.

CONCUSSION, CONTUSION, COMPRESSION, AND LACERATION OF THE BRAIN.—Certain preliminary anatomical facts must be considered, and a brief glance taken at the result of Duret's experiments,[1] before a clear idea can be obtained of the pathology or phenomena of concussion, cerebral contusion, and laceration. Duret's observations on injuries of the dura mater have already been adverted to.

The skull forms an exceedingly elastic case; in proof of which fact, an experiment of Félizet[2] need alone be adduced. He filled a skull with melted paraffine, which was allowed to cool. The skull was then dropped from the height of two and a half feet, and examined. Opposite the point of impact, the paraffine was depressed for an area of more than an inch, the centre of the depression being one-third of an inch in depth, or, in cubic measure, 0.13 of a cubic inch, which was a very considerable amount for such a moderate blow.

The cerebro-spinal fluid is, roughly speaking, divided into two parts, viz., the ventricular and peripheral, communicating with each other by the narrow foramen of Magendie at the lower end of the fourth ventricle. The major part of the ventricular fluid is collected in the lateral and third ventricles, communicating with the smaller quantity in the fourth ventricle through the contracted *iter e tertio ad quartum ventriculum.* The relative bulks of these two portions must be kept clearly in mind. The peripheral portion begins in, or is continuous with, the lymph-sheaths of the fine cerebral arterioles, a fact never to be lost sight of, as it explains disseminated contusion of the brain. The spaces between the convolutions communicate on the one hand with the minute arterial lymph-sheaths, and on the other with larger sacs, the chief of which are located at the base of the Sylvian fissure, a central one at the base of the brain, an inferior cerebellar behind and below the cerebellum, and a terminal sac at the inferior extremity of the spinal cord. The inferior "cerebellar lake"[3] communicates with the fluid of the ventricles through the foramen of Magendie. The subarachnoid space in which is contained the cerebro-spinal fluid, really consists of a delicate meshwork supporting the thin-walled bloodvessels.

I. CONCUSSION OF THE BRAIN.—Concussion is the term used by Duret to indicate the symptoms of a sudden arrest, or suspension, of the cerebral functions, by force transmitted through the cerebro-spinal fluid to more or less distant portions of the brain, mainly, he thinks, to the fourth ventricle. The importance of Duret's experiments must not be pressed too far, but they certainly indicate the manner and points at which much less severe lesions may, and, as will be seen, do, occur in man. The elastic skull, yielding to the blow, compresses the cerebral hemispheres and the peripheral cerebro-spinal fluid. The compression of the hemispheres drives the larger fluid contents through the communicating passage into the fourth ventricle, which is of small capacity, the result being, as Duret found, a rupture of the median line of its floor, and a dilatation of the Sylvian aqueduct and the central canal of the cord. This could not occur, according to hydrostatic laws, if the peripheral fluid was as free to move as the intra-ventricular. What does clinical and post-mortem experience show? That such appearances, much less marked to be sure, are occasionally seen after death, and that similar, but slighter, evanescent lesions would explain in a perfectly satisfactory manner some of the clinical symptoms of concussion. What, however, do we more commonly see in autopsies of concussion cases? Intra-arachnoidean extravasations and effusions of blood into the meshes of the pia mater, with contusions of the brain-substance. Duret shows that these are due to the waves communicated to the subarachnoid fluid, which distends the meshes supporting the bloodvessels, thus resulting in the latter's rupture. This satisfactorily explains the causation of many of these extravasations, but some of these injuries are due to direct transmission of vibrations through the cranial walls. From the wide distribution of the cerebro-spinal fluid, it is clear how force acting upon and through it, produces disseminated lesions. Recalling the fact that the small cerebral arterioles are surrounded by minute prolongations of the subarachnoid space, that is, lymph-sheaths, a ready, and indeed the only, satisfactory explanation of the disseminated form of minute cerebral extravasations is at once found. The impulse of the blow causes distension of the perivascular sheaths, whereby the arterioles are directly compressed, and the capillaries indirectly through the brain-substance; when the pressure is rapidly removed, as when the force ceases to act, "the vessels burst from the unopposed tension of their contents." An equally beautiful explanation of most of the symptoms of concussion is afforded by Duret's observations. From contraction of the arteries, resulting from spasm of their muscular coats, the venous tension at once falls, producing an intense cerebral anæmia which causes the primary loss of consciousness. The spasmodic arterial contraction[1] is followed by a paretic dilatation which may prolong the loss of consciousness. If this be followed by a generalized inflammation, the unconsciousness may be prolonged until death.

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[1] Études expérimentales et cliniques sur les traumatismes cérébraux, tome i., 1878.

[2] Recherches anatomiques et expérimentales sur les fractures du crâne. Paris, 1873

[3] This is Duret's term.

Viewed in the light of these experiments, further explanation of the phenomena of cerebral concussion will be unnecessary, and I shall define concussion of the brain as "An assemblage of symptoms by which we recognize that a sudden arrest or suspension of the cerebral functions has taken place, the result of a commotion of the cranial contents, which may be produced, directly, by force applied to the head, or, indirectly, by an impulse transmitted through the spinal column, as by a fall from a height upon the feet, knees, or buttocks."

Many authors teach that slight cerebral concussion, as evidenced by a momentary loss of consciousness and muscular power, followed by an apparent immediate return to the normal state, is produced by "cerebral vibration without visible lesion," and is due to "a simple molecular disturbance of the cells." This view is the outcome of the histories of several imperfectly recorded cases, where there was no proof that the cause of death was not situated far distant from the head. These were cases of instantaneous death without perceptible lesion of the brain or its membranes; wherefore, argue the vibratory theorists, this absence of all lesion must be still more true for the cases where recovery ensues. Unfortunately for the theorists, neither the spine nor the heart was examined in the cases referred to. Littre's case is eminently suggestive of death from a broken or dislocated spine.[1] Hewett gives two illustrative cases, showing how careless post-mortem examinations tend to perpetuate false theories of disease. One or more of the conditions found in these cases probably existed in those in which instantaneous death was supposed to have resulted from pure cerebral concussion, without any post-mortem evidence of injury to the brain or its envelopes.

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[1] Huguenin, following Fischer, teaches that concussion is due to a reflex paralysis of the intracranial vessels, the result of a powerful peripheral irritation. Anæmia of the arteries and hyperæmia of the veins, he says, are the only constant post-mortem appearances found in concussion. (See Ziemssen, op. cit., vol. xii.) Duret maintains that there is an intense spasm of all the muscles in concussion, which is so transient as generally to be overlooked, but the vascular spasm, from contraction of the muscular coat of the arteries, is more persistent; obstruction is offered to the blood-current; the tension in the veins is enormously decreased; and most marked anæmia of the brain, with the primary symptoms of concussion, results. The congestion is secondary, the result of paretic or inflammatory dilatation from the irritation of the numerous hemorrhagic lesions. It will be thus seen that the latest experimenters have practically arrived at the same results.

A man was admitted into the Hôpital St. Antoine, having fallen from a great height upon the pavement. He was collapsed and insensible, but presented neither paralysis nor muscular spasm. After some hours he died. Upon post-mortem examination of the head alone, not a trace of injury was detected in any of the cranial contents, and the case was considered one of death from cerebral concussion. Fortunately, Dr. Deville, hearing of the absence of all lesions, proceeded to lay open the spinal canal, which he found filled by an extensive extravasation of blood, extending even beyond the point where the spinal cord had been divided when removing the brain.[2]

Hewett also relates the case of a boy suffering from concussion of the brain, whose intracranial contents showed comparatively trivial lesions, while an examination of his chest, which outwardly bore no evidence of traumatism, showed a rupture of the muscular tissue of the septum of the cardiac ventricles, extending up to but not through the serous covering.

But what does actual post-mortem examination show to be the condition in slight cases of concussion, where death has ensued within a short time from other injuries? In two cases reported by Hewett, where "symptoms of concussion of the slightest nature had altogether passed off within a very short time," the brain-substance itself was actually injured. In the first, where there had been mere "giddiness" from a blow upon the head, followed by complete recovery, patches of contusion were found at the base of the brain, in two or three places, of the size of a shilling; these patches consisted of minute specks of blood closely grouped together, extending about a line in depth into the brain-substance. The second case was one where, after a fall upon the back of the head, the concussion-symptoms soon disappeared, and death resulted from another disease eight days subsequently. Thin layers of coagulated blood were found firmly adherent to the parietal layer of the arachnoid, while the larger veins upon the cerebral surface were congested, as well as the brain-substance itself, which was rendered much darker from this cause. In the "centrum ovale, close to the right side of the corpus callosum, and extending partly into it, was an extravasation of blood of the size of a nut."[3] The experiments of Fano upon dogs killed within a few minutes of their recovering consciousness after a stunning blow, show that in the absence of any other lesions most extensive congestion results. Duret's experiments, already quoted, are still more conclusive. Finally, in a case closely resembling that of Littre, already quoted, widespread congestion was discovered.

Arrested, and failing in his efforts to get away, the man dashed himself head-foremost against a wall, his hands being tied behind his back. He was picked up immediately afterwards, perfectly insensible, and died three-quarters of an hour after the injury.

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[1] Œuvres de Sabatier, tome ii. p. 400.

[2] Mém. de la Soc. de Chirurg. de Paris, t. iii. p. 180. (Hewett.)

[3] Hewett, op. cit., vol. i. p. 601.

As far as the brain itself was concerned, there was not even a speck of extravasation either on its surface or in its substance, the consistence of which was perfectly natural. But the intense congestion of the vessels of the brain gave rise to a manifest alteration in the color of its structures, its cut surfaces being thickly studded with the minutest blood-points, from whence specks of fluid blood oozed upon gentle pressure.[1]

What, then, are we to conclude from such evidence as this? Surely, that there is probably no such thing as "cerebral vibration without visible lesion." Certainly my own clinical experience of cerebral concussion has led me to believe that there is some brain-lesion in every case of concussion, however slight it may be. Where no actual extravasation of blood takes place, the paresis of the vascular walls, which, as Duret has shown, follows the primary spasm, produces a congestion which may be evanescent—perhaps of only a few hours' duration—but which, I think, always exists.

Careful scrutiny of the histories and post-mortem records of an extended series of cases, has convinced me that in all cases of so-called concussion of the brain, we have in reality either a disseminated congestion of the organ, or contusion of some portions of its structure. Even in the slightest cases, we may have, as just shown, intra-arachnoid extravasation and ecchymosis of the brain-substance. It is time that the surgical mind should disembarrass itself from the old magisterial views so long taught; since from erroneous views of pathology, bad practice is sure to ensue. The later symptoms of concussion usually detailed, are in reality those of either congestion, contusion, or laceration of the brain-substance—perhaps of all three. In accordance with the parts chiefly injured, so will be, in all probability, the symptoms, although no finely drawn diagnosis can commonly be made, owing to the probably extended nature of the lesions, and the interdependence of the various portions of the brain, both anatomically and physiologically. From these remarks, it must be clear that no table of distinctive symptoms can be given, whereby concussion and compression may be differentiated; since the so-called symptoms of concussion are really those of widely differing lesions of the intracranial contents, varying from a transient paretic congestion to cerebral ecchymosis and laceration. The exceeding variety, in fact the absolute want of constancy, presented by the symptoms of concussion, as to the pupils, the sensorium, etc., clearly indicates that we are dealing with different structural conditions, which the post-mortem room has demonstrated over and over again; yet a recent writer describes as a case of fatal concussion, one in which blood extravasation was discovered in the medulla oblongata.

Symptoms of Concussion.—Should the lesions be entirely or chiefly confined to mere temporary circulatory changes, the patient will probably be either unconscious, or only giddy, for a few moments after a head injury; will get up spontaneously, or with slight assistance; will experience bewilderment of mind; will be unable to collect his thoughts; will have a pale face; and will experience facial sweating, nausea, and perhaps vomiting. In a short time these symptoms will disappear, and the patient will be able to walk, with perhaps slight tremulousness of the limbs; and in a few hours he will be well. This is the rule; but the reader will recall a case just cited, where, with much less evidence of cerebral injury, marked contusion of the brain-tissue existed.

In severe cases, however, we have a much more serious condition. The patient is utterly insensible—pulseless, perhaps—with pallor of countenance, the only evidence of life being a hardly perceptible respiratory effort. The surface is cold, the limbs relaxed, the pupils normal or dilated, or one dilated and the other contracted, and, in any event, responding slowly, if at all, to light. Hemorrhage from the nose is said by Gross not to be an uncommon symptom, and even bleeding from the ears may occur in rare cases, without fracture. If recovery is to ensue, the respiration becomes re-established, at first feeble and intermittent, interrupted by sighing, and then, perhaps—according to the cerebral lesions—noisy or labored. The circulation is feeble and irregular. The urine is usually retained, although there may be incontinence both of urine and feces. The skin is bedewed with a clammy sweat, and the temperature is subnormal, from 94° to 97° F. The special senses are obtuse, the patient usually lying with wholly or partially closed lids, or, when the eyes are opened, apparently not noting visual impressions. By loud shouting and shaking, the patient may be aroused enough to open his eyes and answer in a few short words. This condition, usually described as that of shock or collapse, may last only a few minutes, or hours, or even days. Indeed, the patient may only partially react, to finally die of collapse, apparently, although post-mortem examination will usually reveal extensive brain lesions. If reaction takes place, vomiting is apt to occur, the pulse regains its tone and is less frequent and irregular, the skin becomes warmer and drier, the pallor of the face disappears—giving place perhaps to a flushed countenance—while the mental hebetude is succeeded by the normal condition, or by vertigo, headache, or delirium—in rare instances so violent as to require restraint.[1] Reaction may be succeeded by convulsions in children, and even in adults, or either a partial or general muscular tremor is observed.[2] The moment that reaction transcends a mere return to the normal state, the symptoms cease to be those of concussion—that is, the immediate effects of vibration of the intracranial contents—and at once become the expression of some damage inflicted upon the encephalon by the vibratory waves.

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[1] Denonvilliers, Compendium de Chirurgie, tome ii. p. 606. (Hewett.)

I might proceed to describe a variety of time-honored symptoms said by authors to be due to cerebral concussion, but the reader will see that I have already detailed symptoms which are indicative of extravasation of blood, either into the substance of the brain, or upon its surface. In conclusion, there is no symptom, or set of symptoms, *invariably* present in concussion of the brain. The pulse may be normal, slow, or frequent, and the respirations may be feeble, noisy, or stertorous, although the general account which I have given will apply to the majority of cases. The explanation of these variable phenomena lies in the fact that the cerebral centres of respiration, or of the heart, may be compressed, irritated, or partially destroyed.[3] I believe with Sir P. Hewett, that many of the cases of concussion which have a prolonged convalescence, are in truth cases of extravasation within the arachnoid sac.[4] I must again insist, at the risk of tediousness, that transient or persistent partial paralysis, loss of memory, etc., are not due to concussion—that is, to vibration of the brain-substance—but are the expression of some physical lesion ot the cerebrum produced by that vibration.

The surgeon should be aware that, after reaction from concussion, convulsions and various brain maladies may set in, which, although apparently due to the injury, are, in many cases, merely a rekindling of old disease. Thus Callender relates a number of cases where old epilepsies returned temporarily with unparalleled violence, to again subside. Inquiry should always be made of friends or relatives as to the previous history of patients with head injuries. I lately assisted Dr. C. K. Mills and Dr. Healy in making a post-mortem examination of the brain of a young man, aged 19, who had been stunned by a horse-kick in the *face*, three weeks prior to his death. Upon opening the head, recent meningitis with serous effusion was found, and two small syphilitic tumors of the brain-substance. Here the concussion set up such a degree of congestion and irritation as to render fatal a disease of long duration, which had been quiescent and utterly unsuspected. The head symptoms were first noticed by the patient just about a week after the injury, that is, at the time that intracranial inflammation usually declares itself to the patient, although the physician may perhaps detect its onset at an earlier date.

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[1] Callender, St. Bartholomew's Hospital Reports, vol. iii. pp. 416–418.

[2] In one case of Callender's, what were supposed to be convulsive movements of the right arm were observed. One of the man's companions explained that he was only "steering his boat;" such facts must be kept in mind as explaining certain peculiarities of the delirium of concussion.

[3] See Agnew, op. cit., vol. i. p. 278; also Callender, Anatomy of Brain Shocks (St. Bartholomew's Hospital Reports, vol. iii. p. 415, 1867); and Remarks on the Principal Injuries of the Head, etc., in the Hull General Infirmary (ibid. p. 234).

[4] See Hewett, op. cit., vol. i. p. 602, for two conclusive cases.

Prognosis of Cerebral Concussion.—This should always be guarded. Rapid reaction, vomiting, restored intelligence, normal special senses, absence of severe or constant headache—especially if these negative symptoms persist for some days after the sixth, the usual time of advent of intracranial inflammation—are all encouraging symptoms. Prolonged collapse, relaxed sphincters, a weak, rapid circulation, progressive stupor, and heavy, labored respiration—that is, symptoms indicative of serious cerebral lesion—are almost certain harbingers of death. A relapse into stupor after regaining consciousness, repeated convulsions, and subnormal temperature, are bad signs. "Marked restlessness, screaming, and a rapid pulse," Agnew thinks, are "infallible evidences of approaching death." Excessive reaction, a full, rapid pulse, violent headache, delirium, and intolerance of light and sound, are—as indicative of impending, if not of actually present, intracranial inflammation—symptoms of the utmost gravity.

Treatment.—In the stage of collapse, warmth along the spine and to the feet, with sinapisms to the epigastrium, usually suffices. As we never can be sure whether we are not dealing with a case of intracranial extravasation of blood, or a contused cerebrum, stimulants must be resorted to as little as possible, since under such circumstances "a period of depression would be the safeguard of the patient." (Hewett.) If, however, death seems impending, they must be cautiously resorted to.[1] I prefer hot coffee, which is a good cardiac stimulant, then carbonate of ammonium, and lastly alcoholic preparations, which, on account of their being more readily obtainable, are those upon which we most commonly have to fall back.[2] Prof. Gross recommends the use of stimulating enemata, such as those containing oil of turpentine, etc., but I have had no personal experience of their use in cerebral concussion. Whiskey or ether may be injected subcutaneously if the patient cannot swallow. After marked depression, marked reaction is apt to result, although they are not always proportionate.

Reaction within moderate limits should not be actively interfered with. Perfect quietude of mind and body should be enjoined. Ice, or evaporating lotions, should be kept constantly applied to the head, which, if the case be a serious one, should be shaved. The head and shoulders should be kept slightly elevated. A mercurial, followed by a saline purge, should also be at once administered, and repeated when necessary. If there have been no serious loss of blood, water alone should be given for the first forty-eight hours, or, at most, milk with lime-water. As has already been pointed out, even with no other lesion there is intense cerebral congestion, rendering the affected parts of the brain of an obviously darker hue in those cases where death from other causes permits post-mortem examination. This clearly indicates what is the chief danger of these cases—viz., a distinct predisposition to inflammation, and against this probable result all our efforts must be directed. My invariable rule has been to treat the slightest cases of cerebral concussion as serious, and though much complaint on the part of the patients has resulted, I have never seen cause to regret the course pursued. Bleeding is never indicated in the stage of depression, and I have never had occasion to resort to it even in that of reaction.

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[1] As the senses are so obtuse, great care must be exercised in the administration of fluids by the mouth, lest they gain access to the air-passages, thus producing suffocation. The same may be said concerning strong smelling-salts, aqua ammoniæ, etc., which it is often advised should be held beneath the patient's nose. Laryngeal spasm and subsequent irritation of the air-passages may result from their careless use.

[2] Stimulants, if given even in small quantities *at too short intervals*, may be unabsorbed in the stomach during collapse, to be absorbed as one large dose when reaction sets in, producing, possibly, a dangerous degree of cardiac action.

At a later period, if there are marked delirium, fever, and flushed face, in a robust patient, bleeding from the arm or wet-cupping will prove beneficial. Some surgeons advise small doses of mercurials to affect the system. I see no objection to their use. Bromide of potassium or the deodorized tincture of opium, in repeated small doses, is useful for excessive restlessness or wakefulness. With the subsidence of the acute symptoms, or if exhaustion supervene, a more generous diet must be prescribed, with a cautious resort to stimulants. During convalescence, tonics are sometimes useful. The recumbent posture, gradually changed for the upright by pillows or a bed-rest, should be enforced for at least ten days or two weeks after apparent convalescence has set in.

II. Contusion of the Brain.—Bruising of the brain may be either circumscribed—the more common variety—or disseminated. In the slighter forms of circumscribed contusion, the injured part is seen to be of a dark-purplish color, this coloration being dependent upon numerous, closely-set, minute specks of extravasated blood no larger than pin-points. As the periphery of the ecchymosis is approached, the depth of coloration decreases, owing to the increasing dissemination of the minute extravasations. The cineritious portion of the brain is alone affected in this variety. The consistence of the brain seems but little, if at all, altered, as a gentle stream of water affects neither its color nor firmness. These remarks apply to an examination made within a short time of the injury.

The more severe cases have the central portions of the ecchymosis infiltrated with blood, so that they present a uniform, dark-purple color. Both the white and cineritious portions of the brain are involved. Instead of the pin-point extravasations, in the central portions, small clots of blood of varying size are found, while the periphery presents a series of smaller extravasations more and more widely separated. The cerebral structure is torn and disorganized, as shown by the effects of the impact of even a gentle stream of water, which loosens and washes away the clots, "leaving little pits with irregular and shaggy margins, and thickly studded throughout with pin-point extravasations." (Hewett.)

Examined a few days after the injury, the bruised part will be found to present an irregularly depressed surface, with sharp, ragged borders. The surrounding brain-surface will be probably tinged yellow, with subordinate yellow circles surrounding the lesser extravasations. Either of these two forms of brain-contusion may be found alone, but they much more commonly coexist in the same brain. In the slighter cases, the meshes of the pia mater contain more or less extravasated blood in the form of small clots. The visceral arachnoid, with the pia mater, are usually torn in the more severe cases, in which event the cavity of the arachnoid contains extravasated blood in varying quantity, besides that poured out into the meshes of the pia mater. Sir P. Hewett reports that in sixty-nine autopsies of more or less severe brain contusions, "independent of compound fractures," intra-arachnoid blood-extravasations were found in fifty-two, thirty-one of these being very extensive. In eleven cases, blood was found infiltrating the pia mater for some distance beyond the actual brain lesion, and in six instances "the extravasation was widespread." In the remaining six cases only, was the extravasation in the pia mater insignificant in amount, and limited solely to the site of the brain-injury.

The whole cerebral mass is not equally liable to contusion, some portions being almost constantly bruised in severe head-injuries, while others are so rarely affected as to be almost exempt. This statement is true as autopsies are usually conducted, but it is of importance to note that those portions of the encephalon said to be most rarely injured, such as the pons, crura, and medulla oblongata, may present at the autopsy no external evidences of injury, while careful sections will demonstrate well-marked spots of extravasation. From this fact I am inclined to think that many extravasations are overlooked, especially as Duret has experimentally shown that the floor of the fourth ventricle is peculiarly apt to be injured when severe blows are inflicted upon the head.[1] The medulla oblongata and the crura of the cerebellum and cerebrum are but rarely the seat of extravasations, and when so injured, intra-arachnoid extravasations are apt to coexist. The pons Varolii is an occasional but rare site of bruising.

The cerebellum is quite commonly contused, its under-surface being that portion which is usually injured. The ecchymotic spots are usually small, superficial, and confined to one lobe, although larger extravasations into the deeper parts have been observed, as in a case mentioned by Hewett, or as in one of Blandin's, where multiple minute spots were found scattered throughout the organ. These injuries are apt to accompany lacerations and contusions of other portions of the brain, although they may be occasioned by slight injuries, such as a drunkard's fall in the street.

The cerebrum is more commonly bruised upon its under surface than elsewhere. The extent of injury varies from a few patches of contusion to an extensive bruising of the entire surface of one, or even of two lobes at the same time.[2] Both the cortical and medullary structures may be extensively involved, to such an extent as even to lay open one of the lateral ventricles. The extent of injury done to the cerebral substance is not always commensurate with the degree of force applied. Thus, a case is reported, where, after a fall from a height of only about eight feet, extensive bruising and laceration of the anterior lobes of both hemispheres occurred, and produced a tear into the right lateral ventricle large enough to readily admit the finger. In addition, the deeper portions of the cerebrum may be bruised; and this, too, in some instances, without any injury to the exterior of the organ, or at least without injury corresponding in position to that of the deeper parts. Any portion of the brain is liable to injury, which may be so limited in extent as to escape anything but the closest scrutiny. The septum lucidum was in one case found bruised and torn for nearly its whole length, with spots of extravasation in the remainder of the septum, and in the back part of the fornix. No other brain laceration was found, although blood was poured out in small quantity into the arachnoid sac and pia mater at several points. I am thus particular in quoting cases—to which I shall presently add others—because they demonstrate how readily serious injury to the brain may be overlooked, unless the most minute and skilful *sectio cadaveris* be performed, and how the error of "concussion without cerebral injury" may be thus perpetuated. The only injuries in the cerebral mass which could be detected in another case, were a minute extravasation of blood in the edge of the fornix, a second upon its under surface, and "several specks" upon the surface of the thalamus. In addition, there were extravasations into the pia mater, over the posterior lobes of the cerebrum and the back part of the cerebellum. In still another case, an extravasation of the size of a nut was detected in the right centrum ovale, close to the corpus callosum. This coexisted with several thin layers of extravasated blood in the arachnoid sac. Finally, I would call attention to the post-mortem appearances presented in a fourth case, as illustrative of how serious the results of an apparently trivial lesion may be. Sir Prescott Hewett states that there is, in the museum of St. George's Hospital, a specimen in which the ventricle was filled with blood from the laceration of a large vein, produced by a slight rent in the septum lucidum, which also involved the floor of the left lateral ventricle.

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[1] A case is reported in the Lancet for Nov. 30, 1878 (page 769), from the practice of Verneuil, in which sudden death followed a severe head-injury, and in which the autopsy revealed sub-arachnoid hemorrhage at the "bulb and protuberance." On opening the fourth ventricle, a small central focus of hemorrhage was found in its floor, with two others, one on either side of the median line. These appearances are precisely those observed in Duret's experiments on concussion.

[2] The term lobe here is used in the sense of the older anatomists, where each hemisphere is divided into an anterior, middle, and posterior lobe.

In the disseminated form of cerebral contusion, the foci of extravasated blood, instead of being grouped together, are widely diffused throughout the brain, involving not only the surface but the deeper portions of the organ. In rare instances, the deeper parts may be alone involved. The diffused form of contusion of the brain is a very rare affection, and one not easy of detection, being doubtless often passed by for want of a careful scrutiny of the parts. Diffused contusion of the brain presents itself in the form of minute foci of extravasated blood scattered through the cerebral substance. The size of the extravasations varies from that of the smallest pin-point to that of a split-pea. When of the latter size, the condition will hardly be overlooked, but with the minute variety, the spots are apt to be mistaken for the orifices of cerebral vessels. The two conditions can be readily differentiated by remembering that if the appearances are due to the gaping orifices of divided vessels, the specks can be readily wiped away, the spots reappearing if gentle pressure be made upon the brain. Miliary extravasations cannot be wiped away, and when picked out with the knife-point leave little depressions in the brain-substance. If examined within a short time after the injury, the brain-substance is normal in appearance around the extravasations, but when viewed some days after the accident, little greenish-yellow haloes will be seen around each spot; in other words, the appearances are those presented by a bruise of any other tissue.

Although there are usually numerous miliary extravasations, in some instances there may be so few that only a speck here and there can be detected after most careful search. In one recorded case, three very small extravasations were found in the left anterior lobe, a fourth small one in the fornix, and a fifth in the right lobe of the cerebellum. There were a few minute extravasations into the arachnoid and pia mater, but no fracture of the skull existed.[1] I hope that I have made it sufficiently clear that, whether circumscribed or disseminated, these extravasations are not the lesions of concussion, but of *contusion* of the brain. When diffused, they are the result of the sudden removal of pressure from the previously distended perivascular lymph-sheaths, tensely filled by the impulse impressed on the cerebro-spinal fluid by the compressing force, which, as demonstrated by Duret, the blow exerts upon the elastic skull.[1] Oftentimes there is direct contusion beneath the part of the skull struck, but it rarely exists alone, being accompanied by ecchymoses in other parts of the brain, except when it is a direct result of the depression of fragments. In many cases the extravasation is directly opposite to the point struck, seemingly the result of counter-stroke. Direct contusion and that by counter-stroke are apt to coexist in severe head injuries.

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[1] Hewett, op. cit., vol. i. p. 607.

The upper portions of the brain rarely suffer from contusion, for of thirty-six cases of fracture which started in the vault, but extended into the base, in only five was bruising of the upper surface of the hemispheres detected. (Hewett.) All portions of the base of the brain are not equally liable to be bruised. The middle lobes are those most frequently contused, the anterior ones less often, while the posterior are still more seldom injured. Of the thirty-five cases referred to by Hewett, the middle lobes were bruised in twenty-five, the anterior in eighteen, and the posterior in only four. In twelve of these cases, where the injury was exceptionally severe, both the anterior and middle lobes were contused. As to the reasons for this preponderance of injury in one part more than in others, I cannot accept Sir P. Hewett's and Sir B. Brodie's explanations, as they seem to me not sustained by anatomical considerations. In the *macerated* skull there are, indeed, a number of "irregular and angular projections," but in the *fresh* skull, I deny that they exist. In the section on fractures of the cranial base, I have tried to render these points clear, and to explain why the middle and anterior lobes are so commonly contused.

Symptoms and Diagnosis of Cerebral Contusion.—These are so uncertain as to render it exceedingly doubtful whether these lesions have any characteristic symptoms of their own. In the absence of fracture—probable or ascertained—after the first symptoms of shock have passed off, if there be pronounced unconsciousness, or marked somnolency, with the absence of stertor, or if there be extreme agitation and restlessness, it is exceedingly probable that contusion is present. If there be rigid contraction of one or more of the limbs, or of isolated groups of muscles, especially those of the fingers, the probability amounts almost to certainty. Now, if to these we have added marked isolated palsies, I think that we are justified in assuming the existence of contusion, provided that irritating lesions of the dura mater can be excluded. These, as I have already said, are more apt to occur on the side of injury—supposing this to have been produced by a circumscribed application of force—and never produce paralysis. Slight effusions of blood into the arachnoid sac are usually attended by no symptoms. Even when blood is effused in larger quantities, the symptoms are commonly those of compression of the brain-substance, not of irritation, and where both sets of symptoms coexist, I consider those of irritation to be due to concomitant brain-contusion. In mild cases of contusion, partial contraction of one pupil, partial paralysis of an eyelid, impaired vision, thick speech, slight spasmodic twitching of the facial muscles, one or all, have been noted. Unless there is evidence to the contrary, if after the application of severe diffused force to the skull, marked brain-symptoms—other than hemiplegia—persist after the shock has passed off, cerebral contusion and laceration will in most instances be found after death. I hesitate to thus differ from such a distinguished authority as Sir Prescott Hewett, recognizing, as I do, the fact that severe brain-bruising may exist without presenting any symptoms until several days after the injury, or indeed that they may be altogether wanting. But if, because the diagnosis is difficult, and because mistakes must sometimes occur when a positive opinion is ventured upon, the surgeon should be discouraged from making the attempt, he must abandon all hope of any further advance in the diagnosis of head injuries.

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[1] See Duret's experiments, p. 53, *supra*.

There is one variety of brain-bruising which I am confident that I have met with on a number of occasions, and which I shall now proceed to describe. To this condition Mr. Erichsen has applied the term "cerebral irritation." I have over and over again recognized the accuracy of his description. The probabilities are that in these cases the cortical matter of the brain is diffusely contused, and intensely congested—possibly the latter alone. The patient assumes a peculiar and most characteristic attitude, lying upon his side "curled up in a general state of flexion." The head is bent upon the chest, the trunk is bent forwards, the knees are drawn up on the abdomen, the legs are bent, and the arms flexed with the hands drawn in. The patient "does not lie motionless, but is restless, and often when irritated tosses himself about." "However restless he may be, he never stretches himself out or assumes the supine position, but invariably reverts to the attitude of flexion." He violently resists every effort to open the firmly closed eyelids, but, if this be done, the pupils will be found contracted. The skin is pale, cool, or cold; there is no heat of head; the pulse is slow—seldom above 70—small and feeble. The sphincters are usually unaffected, the patient emptying the bladder when it requires it, although retention of urine sometimes occurs. "Irritability of the mind is the prevailing characteristic." Unconscious, and paying no attention to what passes, when loudly called to, the patient "shows irritability of temper, frowns, turns away hastily, mutters indistinctly, and grinds his teeth." There is no stertor during sleep. After the lapse of from one to three weeks, the pulse improves in quality, the surface temperature increases, and the tendency to flexion subsides, the patient lying stretched out. Irritability of temper "gives way to fatuity," and the mind is evidently weak. Recovery is apt to be slow, but may eventually be perfect. Secondary complications may of course ensue at a later period. Erichsen says that "cerebral irritation" usually follows blows upon the forehead or temples, but the most marked instances which I have seen have been from injuries to other regions of the head.

Prognosis.—Contusion of the brain is a most dangerous injury, yet some cases end favorably. When recovery takes place, the contusion is repaired in the same manner as are apoplectic hemorrhages into the brain. In the slighter cases all traces may have disappeared, or a more or less dense cicatrix, with possibly some central coloring matter, may be detected, when death occurs independently of, and some time after, the injury. As an instance of the methods of repair in the more severe cases, Sir P. Hewett[1] thus describes the appearances seen in a case of extensive brain-contusion and laceration, twenty years after the accident:—

> The convolutions of the anterior parts of both hemispheres of the brain were extensively excavated, and here the arachnoid and pia mater were carried evenly over both depressions, so that a space was inclosed beneath them, which was filled by loose areolar tissue and serum. In the right hemisphere, the mouth of the excavation was nearly circular, about an inch and a half in diameter, and so placed that the inferior margin lay close to the base of the brain, whilst the inner one was close to the median fissure. The depth of the excavation was about an inch, and the convolutions about its edge were natural. The cavity commenced, for the most part, abruptly, but one or two convolutions could be traced in a stunted condition down the walls, which had an even surface, and were loosely coated with areolar tissue.
>
> In the corresponding part of the left hemisphere, there was also an excavation similar in all respects save that it was only about half the size of that in the right hemisphere.

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[1] Op. cit., vol. i. p. 609.

The cerebral tissue, in the neighborhood of these cavities, and forming their walls, had a perfectly healthy appearance. There were no remains of blood extravasated in the cavity of the arachnoid; the other parts of the brain were perfectly healthy, and so, too, was the brain-case; no traces of fracture; no sign of injury to the bones. The patient died of aneurism of the subclavian artery, at the age of forty-eight, but twenty years before his death, when I was house-surgeon, he had been admitted into St. George's Hospital with several other men, all of whom had fallen a great height in consequence of the giving way of some scaffolding. At the time of his admission he was suffering from several severe injuries; and especially of the head, marked by the symptoms of so-called concussion of the brain, but there was no sign of fracture of any part of the skull. For several days he struggled between life and death, in a state of perfect unconsciousness, followed by violent delirium, which ultimately, however, subsided, and in a few weeks he was so far well that he was able to leave the hospital. After a while he resumed his occupation, that of a house decorator, and for years he worked for one of the best firms in London, and was known as one of their ablest workmen. His intellect was as clear as it had ever been, and when I accidentally met him, from time to time, he always said that he did not suffer more from headaches than other people.

Treatment.—The chief danger is that of encephalitis, against which all our efforts are to be directed. As inflammation of the brain and its membranes, after such injuries, is apt to pursue an insidious course, every head injury which presents indications that the intracranial contents have suffered even in a minor degree, should be most assiduously watched, as traumatic intracranial inflammation often suddenly declares itself, after a number of days of deceptive calm. Usually the incipient indications show themselves not later than the fifth day, but their advent is sometimes much longer delayed.[1] The therapeutic measures to be adopted are those recommended for warding off encephalitis, and when these efforts fail, those advised for intracranial inflammation should be instituted.

III. Compression of the Brain.—Any diminution in the capacity of the cranium must, from the presence of the cerebro-spinal fluid, exert an effect at all points occupied by that fluid. This increased tension compresses the vessels, and, by the consequent anæmia, causes disturbances of the functions of the encephalon. Theoretically, when this tension equals that of the blood in the vessels, death results. This point, probably, can never be reached except in experiments, as Duret has shown that the vascular spasm produced by irritation of the sensory nerves, or their centres, at once enormously increases the intra-vascular tension. He has shown that a clot amounting to one-twelfth of the cranial capacity, between the dura mater and the bone, will produce coma and death in a few hours. In the arachnoid cavity, however, a clot of one-sixth or even one-fifth the bulk of the cranial cavity is requisite for a lethal effect. These results are only true when no lesion of the nerve-centres coexists.

Although not by any means scientifically accurate, "compression of the brain" is a term so commonly used as to need no apology. Its causes are exceedingly various. Thus a foreign body, such as a bullet lodged in the brain, depressed bone, extravasation upon the surface or into the substance of the brain, and frequently all the last three, coexisting, may produce symptoms of compression which are then usually primary. Inflammatory products, viz., serum, lymph, and pus, are causes of secondary compression.

Symptoms.—Due as these are to such varied and often combined conditions, there are only a few symptoms which are always present. Before insensibility comes on, pain in the head is complained of, doubtless the result of pressure and tension on the sensitive dura mater. The patient lies on his back in a more or less comatose condition, is unconscious, and breathes with a slow, stertorous respiration, often accompanied by a peculiar whiff at the corners of his mouth, as if he was smoking. The last-mentioned symptom appears to be due to paralysis of the cheek muscles, and is a sign of bad prognostic import. The pulse is full, and usually slow; the skin is cool, or it may be, as in one case which I recall, very hot and dry; or again, it may be hot and moist. The pupils are at first sluggish, and then fixed and immovable, being moderate in size, widely dilated, or one dilated and the other normal or contracted. This condition varies, as we have seen, with the part of the brain affected,[1] or with the presence or absence of intracranial extravasation of blood. There are retention of urine and fecal incontinence. There is paralysis of motion, usually affecting one side, but there may be right hemiplegia with spasmodic contractions of the left side, or only certain groups of muscles may be affected, according to the particular form of brain injury. General tremors or convulsions may occur. The most constant symptoms are coma, stertor, and paralysis. When death ensues, respiratory paralysis is the cause, whence the plain indication to resort to artificial respiration. The fundus oculi presents certain changes in well-marked cases of compression, such as venous stasis with relatively small arteries, and slight reddening of the papilla. Apoplexies of varying extent can sometimes be detected. Commencing *neuro-retinitis descendens*, with turbid redness of the papilla and indistinctness of its outline, may be noted, or—a very common form—stasis and œdema of the papilla, in addition to the neuro-retinitis, that is, "choked disk."[2] These symptoms can only be detected in compression which lasts for some time, and usually result from the secondary compression exerted by pus—abscess of the brain, or diffuse suppurative cerebritis. When compression is due to a foreign body, or to depressed bone, the symptoms will be immediate, the patient being probably unconscious from the moment of injury. If the compression results from intracranial hemorrhage, it will come on gradually, in most cases after a distinct interval of consciousness, when the symptoms of concussion have partially or completely passed off. If due to cerebral contusion and parenchymatous hemorrhage, consciousness will not return after the injury, but the concussion-symptoms will steadily merge into those of compression. If resulting from the pressure of serum, lymph, or pus, the symptoms of compression will set in at a later period of the case, and commonly after distinct indications of intracranial inflammation.

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[1] See section on Pachymengitis, Arachnitis, etc., p. 74, *infra*.

Diagnosis of Cerebral Compression.—From what has been said concerning concussion and compression, it will be seen that in most severe cases the distinction cannot be made, since the symptoms are oftentimes produced by similar injuries, the two conditions presenting differences only of degree. Concussion in its first stage has no definite symptoms beyond those of shock and syncope—which may be also present at the incipiency of compression—while if extravasation or cerebral contusion exist to any marked degree, symptoms resembling those of compression will probably present themselves almost from the outset. Slight causes of compression, such as a limited depression of bone, or small extravasations of blood, may produce only evanescent symptoms, the brain soon accommodating itself by virtue of its displaceable cerebro-spinal fluid. Thus in many cases no positive diagnosis is possible, since, as investigation has shown over and over again, no one diagnostic symptom can be implicitly relied upon. Of course, when a patient suffers from profound coma, with hemiplegia, dilatation of one pupil, stertorous respiration, etc.; or when he recovers consciousness after stunning, to again relapse into coma, with hemiplegia, etc., we can confidently pronounce the cause of the trouble to be compression. Those who see many severe head-injuries, and the results of post-mortem examination, will concur with me, I am sure, in expressing the opinion that it is eminently misleading to the younger practitioner to authoritatively tabulate the diagnostic symptoms of compression and concussion. It is a relic of ancient magistral surgery which it is time should be dispensed with.

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[1] See Concussion of the Brain, *supra;* also Leyden's experiments, Ziemssen, op. cit., vol. xii. p. 666.

[2] See section on Cerebral Abscess, p. 80, *infra.*

Prognosis.—This depends upon the cause. If slight, the patient regains consciousness and recovers. In other instances the cause may be a removable one, when, if the concomitant cerebral injuries are not in themselves mortal, recovery often ensues. The later forms of compression of the brain by lymph and pus, are peculiarly grave, and unless remediable by the surgeon's giving them free vent—and too often then—they sooner or later destroy the patient.

Treatment.—This has been so fully dwelt upon under various other heads, that I need only refer the reader to the sections on intracranial hemorrhage, intracranial abscess, foreign bodies in the brain, fractures of the skull, etc. I would however call attention to the possibility of resuscitating a patient even apparently dead from respiratory failure, after the cause of compression has been removed, by means of artificial respiration, the hypodermic use of atropia, and electrical stimulation of the diaphragm. This sudden respiratory failure is more common than is ordinarily supposed.[1]

IV. Laceration and Protrusion of Brain-substance; Hernia Cerebri.—Bruised and lacerated fragments of brain-tissue may be driven through a fracture situated in any part of the skull, but such injuries are usually the result of compound fractures of the vault, the force producing which at the same time ruptures the meninges. Very rarely the brain-substance is extruded through a basal fracture of the skull, in direct communication with the ear, nose, or pharynx. Brain protrusion would occur more commonly with fractures of the base, were it not that they usually consist of mere fissures of the bone, without any laceration of the dura mater. When such an accident does occur, it must necessarily be, with rare exceptions, fatal, from the violence of the force producing it, and from the consequent intracranial damage.

Hewett reports a case seen at St. George's Hospital, London, where a profuse hemorrhagic flow from the left ear, containing fragments of brain-substance, resulted from a fall upon the vertex, from a great height.[2] Two other similar cases are referred to by him, the original histories[3] of which I have carefully perused, and which I find closely resembled that above mentioned. I am acquainted with only three recorded cases where brain-matter has been forced through the nostrils, and in one of these recovery followed.[4] I append brief notes of two cases of recovery after protrusion of brain-substance.

A man, aged forty years, fell from a scaffold, a height of twenty feet, striking with his head some iron bars; he was stunned, but upon admission to the hospital, half an hour later, he had recovered consciousness. There was a small wound over the right eyebrow, sticking in which was seen a fragment of brain-substance. There was slight hemorrhage from the right nostril, while the pulse and respiration were undisturbed, and only some pain in the head was complained of. The next day a fragment of the brain, of the size of a hazel-nut, together with some blood-clot, escaped from the right nostril. The inner wall of the frontal sinus had been broken, which afforded a means of exit for the lacerated brain.[1]

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[1] See Cerebral Abscess, p. 80, *infra.*

[2] Op. cit., vol. i. p. 610.

[3] Journ. de Méd. et de Chirurg., tome iii. p. 454. 1779; and Annales de Chir., tome viii. p. 229. 1843.

[4] Compend. de Chirurg., tome ii. p. 595; Bull. de la Soc. Anat. de Paris, p. 228. 1837; Am. Jour. Med. Sciences, April, 1859, p. 354.

A seaman, on board the United States ship Constellation, fell from the mast-head through a hatchway, landing full upon the vertex. Copious bleeding from the ear, estimated at from 50 to 60 fluidounces, occurred within a few hours, and mingled with the blood were small fragments of brain-tissue. This was followed the next day by a free watery discharge from the auditory meatus, in which were found several small pieces of true brain-substance. In five weeks the man had returned to duty, only complaining of giddiness and a "stuffed-up" head.[2]

After an extensive search through the literature of the subject, I can find no record of brain-substance having been forced into the pharynx; but Hewett says that he has seen the contents of the pharynx within the skull, to which they had gained access between the widely separated fragments of a fracture of the cranial base.

Prognosis.—As just said, nearly all cases in which cerebral protrusion occurs at the base of the skull, terminate fatally; but when the vault is involved, although the injury is a most dangerous one, it is not necessarily mortal, since the records of surgery contain a large number of instances where recovery has ensued after losses of considerable portions of brain-tissue—recoveries, too, in many instances, without any apparent sequelæ, either mental or physical. I have been present myself at an operation, performed by another surgeon, where several teaspoonfuls of brain-substance were lost, and where yet the patient made a good recovery. Two high authorities are diametrically opposed to each other as to which is the most dangerous region for these injuries, Brodie[3] saying that he could discover no record of recovery where the posterior lobes of the cerebrum were involved, while Guthrie thought that an injury of the forehead was far more dangerous than one of the back of the head, and that injuries of the side or middle of the cranium occupied a mean place as to their mortality.[4] I am unable to throw any light upon this vexed question, but am inclined to think that each case must be considered by itself, and that all generalizations must be fallacious where the lesions are so exceedingly varied.

Treatment.—This must be that of other severe head-injuries, with special reference to the probability of the formation of secondary protrusion of the brain-substance, or hernia cerebri.[5]

Hernia Cerebri.—In the great majority of cases, this protrusion consists largely of true brain-substance. This has been proved macroscopically—in one case of Mr. Stanley's the cortical and medullary substance were readily distinguished by the naked eye—and microscopically, as in Mr. Hewett's case, where "many nerve-tubules were detected in every portion thus submitted to the glass." In some cases the mass has been described as consisting chiefly of blood effused beneath the pia mater, while in others the tumor has been found to consist of a mass of hyperplastic granulation-tissue. Although almost always the result of a fracture with consequent rent of the dura mater, or when that membrane has been purposely or accidentally opened during an operation, hernia cerebri may result from syphilitic caries, as in two recorded cases.[1] The opening through the dura mater may be primary, or may occur at a later date from sloughing of that membrane. The presence of splinters of bone, piercing and irritating the dura mater, seems peculiarly apt to give rise to hernia cerebri. The time of its appearance is most various. It may be quite voluminous, as I have seen it, within twenty-four hours, or it may not appear until the sixty-eighth day;[2] but in most instances it has been first noticed from the fifth to the seventeenth day, that is, when inflammation has set in and is well under way. Large portions of the cerebral substance may be destroyed, as in a case of M. Bouchacourt,[3] where the lateral ventricle was laid open—as shown before death by the large quantities of limpid fluid which came from the wound, and after death by direct examination. There is often a great apparent loss of brain-tissue before death, when at the autopsy but little cerebral substance is found to have been destroyed; which shows that much of the protruded mass, in certain cases, must have consisted of granulation-tissue, extravasated blood, infiltrated serum, etc. The swelling is usually painless on pressure or incision, although in a few cases evanescent pain has been complained of when the mass has been cut away. The subjacent brain-substance is soft, swollen, and œdematous, and the whole brain is often infiltrated with serum, and contains abscesses, or the ventricles may be filled with large quantities of fluid; all these conditions may coexist. Extensive intra-arachnoid and sub-arachnoid effusions of pus and lymph are commonly found. Although, in a general way, the truth of Guthrie's statement is borne out by experience, that protrusion of the brain-substance is more apt to take place when there has been a limited removal of bone, yet M. Bouchacourt's[4] case, and two others mentioned by Hewett, prove that the contrary may be true. As in the case of primary brain-protrusion, from the rarity of gaping of basal fractures and consequent rupture of the dura mater, hernia cerebri rarely occurs except in the vault of the skull. With the necessary pre-requisites, however, that is, removal of pressure by destruction of the bone and dura mater, secondary brain-protrusion may occur at the base. Thus, a boy under the care of Mr. Cæsar Hawkins received a pistol-ball wound through the right malar bone, with lodgment of the missile in the head. There were no marked cerebral symptoms for seven days, when he became restless and delirious. That afternoon a soft fungus showed itself in the wound, and he died thirty hours later. Post-mortem inspection revealed a large gap in the sphenoid and temporal bones, through which quite a large mass of brain-substance projected. The substance of the brain around the protrusion was vascular, and of the yellow color usually found in such cases.[5]

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[1] Medical Gazette, new series, vol. iii. p. 77. 1846.
[2] Amer. Jour. Med. Sciences, April, 1859, p. 354.
[3] Med.-Chirg. Trans., vol. xiv. p. 421.
[4] Guthrie, Injuries of the Head. Commentaries on the Surgery of War, 6th edit., p. 284.

The tumor, pressing its way externally, when it reaches the level of the cranial walls, tends to spread mushroom-like over the contiguous scalp. Its surface is irregularly indented, soft and discolored with blood, or gray and firm. The protrusion may be only moderately vascular, or may be most abundantly supplied with blood, and may pulsate synchronously with the brain. Portions are apt to slough away from time to time, so that in some cases the whole tumor may drop away piecemeal, cicatrization of the wound, and cure, following; or again, *pari passu* with the sloughing away of portions of the growth, new protrusion may take place, until the patient finally dies exhausted. In one case reported by Quesnay, the patient tore the whole mass away, a cure resulting. Finally, without sloughing, the hernia may gradually shrink, and totally disappear.[6]

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[1] Med.-Chirurg. Trans., vol. viii. p. 45. Gross, op. cit., vol. ii. p. 78.

[2] Laurie, Lond. and Ed. Monthly, June, 1844, p. 478.

[3] Bull. de la Soc. Anat. de Paris, tome xiii. p. 13.

[4] Loc. cit.

[5] Hewett, op. cit., vol. i. p. 612.

[6] Laurie, loc. cit.; Crawford, Edinb. Med. and Surg. Journ., vol. xii. p. 22.

Pathology.—The removal of pressure, in conjunction with softening of the cerebral tissue, renders a very slight increase of intracranial tension efficient as a cause of protrusion of a portion of the brain-substance. This is shown by cases where it has followed cranial necrosis. In all other parts, a hyperplastic induration of the connective tissue commonly takes place, whereby pus, if it forms, is limited. In the brain-tissue, the delicate neuroglia readily allows of infiltration with inflammatory products, and its acute hyperplasia, instead of strengthening, seems to weaken the tissue, so that the brain readily yields to the least pressure. Now intracranial inflammation with cerebral softening is usually present at the time when hernia cerebri makes its appearance, and at a stage, too, when free effusion into the ventricles, arachnoid sac, and substance of the brain, is prone to occur. In those rarer cases which occur within the first forty-eight hours, I would suggest that the condition is probably due to the paretic dilatation of the vessels observed in concussion, which is, as pointed out by Prof. Agnew,[1] commonly followed by free exudation of bloody serum.

Symptoms.—They are those of inflammation of the brain and its membranes, and therefore need not be dilated upon. It is interesting to note that there may be almost a complete absence of all symptoms beyond slight rambling of speech, occasional twitching of the facial muscles, broken sleep, and a full pulse. Not unfrequently the patient dies of pyæmia.

Diagnosis.—This can hardly be confounded with any other affection except the "tumeur hématique" of Velpeau, which arises from a mere effusion of blood upon the outer surface of the dura mater. I do not know of any special diagnostic points, but as such tumors are among the great rarities of surgical practice, they can but rarely give rise to mistakes.

Prognosis.—Although a very fatal complication, recovery does occasionally ensue. Thus, of 80 cases which I have collected, 25 ended favorably, and 55 in death. Of the patients who recover, the majority suffer from vertigo, headache, etc. I do not presume to say that such a small number of cases settles the percentage of mortality, but merely give the figures for what they are worth, as a lethal issue is commonly quite as much the result of concomitant injuries, inflammation, etc., as of the hernial protrusion.

Treatment.—In general, the less done the better. As the cause is primarily loss of support, gentle pressure at the outset, with the use of some antiseptic absorbent dressing, may be advantageously tried. The parts should be frequently cleansed with some antiseptic astringent wash. Removal by the knife, tearing, or ligature, must in general be avoided, especially where granulations are springing upon or around the protrusion, as we should thus still further remove pressure and encourage the growth. The removal of protruding brain-masses is rarely, if ever, effectual, and experience shows that they at times disappear spontaneously. As the intracranial inflammation, in most instances, stands in a causative relation to hernia cerebri, appropriate treatment for that condition is indicated. Great care should be exercised to remove, when possible, all fragments of bone which may irritate and injure the dura mater and brain. Mallet, Hewett, and other surgeons report a number of apposite cases where bony fragments, by causing sloughing of the dura mater and irritation of the brain, have apparently favored the formation of hernia cerebri. Special attention should be paid to the state of the circulation, which, if over-excited, must be controlled by appropriate remedies. This is, however, as pointed out by Laurie, rarely the case.

Wounds of the Brain and Meninges.—According to the nature of the vulnerating body, these may be incised, punctured, lacerated, contused, or gunshot wounds. The contused and lacerated varieties may be produced without fracture of the skull, but this accident almost necessarily precedes the more severe forms.[1] Punctured wounds may be caused by spicules of bone driven down into the substance of the organ, but most frequently result from thrusts with penknives, forks, dirks, pointed pieces of wood, nails, ferules of umbrellas or walking canes, etc. Those portions of the skull most often perforated are the orbital plates of the frontal bone and the cribriform plate of the ethmoid, although in young children any portion of the skull may be thus injured. Gross states that a bad punctured fracture sometimes results in children from a blow by the spur of an enraged cock.[2] The brain has been traversed from one extremity to the other by balls, swords, bayonets, ramrods, etc. In one case reported by Larrey, a ramrod passed through a soldier's head without wounding any important structure:—

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[1] Op. cit., vol. i. p. 277.

A metal ramrod entered the head of a soldier in the middle of the frontal bone, making its exit upon the left side of the neck, and was so firmly imbedded as to defy all efforts at removal. After death, the missile was found to have passed between the cerebral hemispheres without wounding them, but tearing the falx; after which it pierced the body of the sphenoid bone, and finally emerged through the occipital bone near the foramen magnum. This patient lived two days.[3]

Incised and punctured wounds of the brain, when small and clean-cut, may, according to Rokitansky, sometimes heal by adhesion. In minor degrees of contusion, repair is effected as in ordinary apoplexies.

A superficial mortification of the contused parts may occur, the extent of the process depending upon the degree of the contusion. If slight, the processes peculiar to red softening occur at the points of injury and in the surrounding tissue. When the bruising is more severe, a dark-brown, pulpy mass is apt to be found in the centre of the injured spot, around which is seen a broad zone of intense congestion, with numerous capillary apoplexies. Outside of the belt of congestion, one of inflammatory œdema will be detected.

In other instances, acute, diffused, superficial suppuration occurs, which is invariably accompanied by meningitis. The suppuration is not limited to the surface contusions, but a number of small abscesses are grouped around the superficial one.

A contusion of the brain-substance which results in encephalitis, may not end in suppuration but in yellow softening. This is especially true in regard to contusion of the punctiform variety. Here the initial necrotic changes are more pronounced than those of inflammation; hence the appearance of yellow softening. In many cases further changes take place. The softening may extend until large portions of the brain are involved. This is rendered possible by the border zone of œdematous brain-tissue, wherein the nerve-elements already have their nutrition seriously impaired. Even with compound fracture of the skull, neither inflammation nor yellow softening invariably occurs, when the contusion consists simply of capillary apoplexies. After death, these injuries, when the patient survives some time, are evidenced by a slight thickening around a small collection of fat granules, granule-cells, and hæmatoidin crystals. Finally, slight contusions may—in very rare instances where the skull is not opened—result in circumscribed yellow softening, without any trace of inflammation. These spots of softening may give rise to no trouble for prolonged periods, and then unfortunately, under entirely unknown conditions, a rapid extension may set in and terminate fatally. The clinical history of these cases of consecutive softening is not clear, and closely resembles that of brain-abscesses.

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[1] See sections on Contusion of Brain and Fracture of Base of Skull.

[2] Op. cit., vol. ii. p. 76.

[3] Larrey's Mem. Mil. Surg., vol. ii. p. 313. Am. ed. 1814. I need hardly do more than refer to the famous case recorded by Harlow and Bigelow, in which a tamping iron, weighing over 13 pounds, was blown through a patient's head, and yet recovery ensued.

Wounds producing loss of substance heal by granulations, which fill up the cavity, adhesion taking place between the resulting granulation-tissue and the cicatrix which closes in the opening through the bone and meninges. Rokitansky shows that, under these circumstances, the lateral ventricle on the side of injury enlarges, to partially supply the place left by the loss of cerebral tissue.

At a later period, the brain tends to sink inward, and by this process of stretching of the cicatrix, a loose connective tissue, with its interstices filled with a serous fluid, comes to lie between the brain and the superficial scar, where the two structures were formerly firmly bound together.

Prognosis.—This is dependent upon the portion of the encephalon wounded, and upon the concomitant injuries. With a limited lesion, and one not compromising the integrity of the involved brain-tissue, recovery is possible, and indeed under judicious treatment has often taken place readily. Recovery is also compatible with destruction by bruising and tearing of large portions of the brain-substance, although the danger is usually proportionate to the extent of tissue involved. Large portions of brain may be lost, and yet, provided that neither the motor area nor that of speech be involved, no apparent loss of intellectual power nor disorder of motility may be detected.

The preceding remarks are chiefly applicable to injuries of the superior and lateral surfaces of the hemispheres, for if wounds involve the base of the brain, or the medulla oblongata, the respiratory centre may be involved, when instant death from cessation of breathing will occur. Even when those centres which are immediately necessary to life are not at first involved, they generally become affected sooner or later, either by contiguity of structure or from pressure of inflammatory products, when death follows.

Should recovery take place after basal injuries, it usually does so with marked impairment of the mind, and varied palsies of motility and sensation. The special senses also are apt to be lost or impaired. Nothing like certainty in prognosis is possible, as the most frightful injuries may be recovered from, while the most trivial may result in death. In the words of Percival Pott, however, "no injury is too great to be despaired of." The chief dangers to be apprehended are encephalitis and hernia cerebri.

Symptoms.—These are so dependent upon the portions of brain involved, that it would be useless to attempt to detail them.

Wounds of the meninges are always grave, indeed often as fatal as wounds of the brain itself. Suppuration and sloughing of the dura mater generally follow contused wounds, with a consequent, diffused, intracranial inflammation, and in very many cases hernia cerebri results. These evil consequences are peculiarly apt to follow from the irritation caused by depressed splinters of the inner table, whence arises the practical precept to remove these by operation, when such untoward results may oftentimes be avoided.[1] A portion of dura mater which might have recovered its vitality if the pressure and irritation of bony fragments had been removed, is too often "left to nature" as it is said, and with fatal consequences.

Extensive incised wounds of the meninges, removing considerable portions, as in sabre wounds where large segments of the cranium have been sliced off, not infrequently end in recovery, as in cases reported by Hennen,[2] Larrey,[3] and others.

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[1] See section on Hernia Cerebri for the influence exerted by bony spicules in causing this affection.

[2] Hennen, op. cit., p. 231.

[3] Larrey, op. cit., vol. ii. p. 281.

Treatment of Wounds of the Brain and Meninges.—This should embody the prophylactic and curative measures appropriate for encephalitis, to the section upon which subject the reader is referred.

FOREIGN BODIES IN THE BRAIN.—Foreign bodies may become encysted, either actually imbedded in the cerebral tissue, or merely lying in contact with the exterior of the brain. Their usual tendency is sooner or later to induce fatal inflammation, even after years of immunity from all trouble. Foreign bodies like bullets, may remain lodged in the brain for years, when a drinking bout, or some extraordinary mental excitement, may bring about sudden death. (Quesnay, Hennen, Wharton.) "In a case observed by Dr. John E. Gibson, of Nashville, the ball remained in a quiescent state in the anterior lobe of the brain for six years, when it excited fatal inflammation."[1]

In an admirable paper by Dr. H. R. Wharton, of Philadelphia,[2] published in 1879, that surgeon gives an analysis of 316 cases where a foreign body was lodged in the brain. Of this number, one hundred and sixty ended in recovery, while one hundred and fifty-six proved fatal. The influence upon recovery of the removal or retention of the foreign body was most marked. The foreign body was removed in one hundred and six cases, seventy-two patients recovering, while only thirty-four died. In the remaining two hundred and ten cases, no attempt at removal was made, and recovery took place in only eighty-eight cases, while one hundred and twenty-two patients died. A further analysis shows that among those classed as recoveries, death ultimately took place in ten cases at periods varying from three to fifteen years, and that many of the patients suffered from such after-effects as vertigo, incapacity for physical exertion, loss of sight or hearing, epilepsy, and deterioration of the mental powers.

Still further, of those cases in which the patients recovered without manifesting any of these sequelæ, numbering in all one hundred and eleven, the foreign body was removed in fifty-six cases, and allowed to remain in forty-five. The evil results of allowing a foreign body to remain in the brain are usually manifested sooner or later—even as long as thirteen years after the injury. Inflammation, slow or rapid, sometimes involving large portions of the brain tissue, or yellow softening, is apt to be set up around the foreign substance, either spontaneously, so to say, or from the most trivial exciting causes.[3] The usual termination is cerebral abscess, this condition having been found in fifty-three of Wharton's cases, in which a post-mortem examination was obtained. Apoplexy is an occasional cause of death, as is pressure of the foreign body on the venous trunks, inducing ventricular effusion and consequent compression of the cranial nerves. Convulsions, coma, etc., have also been thought to have originated from venous pressure. The probable explanation of those cases in which no symptoms have been present for long periods, but in which death has rapidly followed upon the sudden development of brain-symptoms, is that quoted by Wharton from Flourens. The latter observer introduced bullets into different portions of the upper parts of the hemispheres, and upon the cerebellar lobes of dogs and rabbits. By their own weight the balls gradually penetrated the brain-substance, ultimately reaching the basis cranii, the bullet tracks healing after them. In man, something analogous probably takes place, thus accounting for the late supervention of rapidly fatal symptoms.

As to the fatality of wounds of the different portions of the brain, fifty-eight deaths took place out of one hundred and thirty-two cases where the foreign body entered through the frontal bone. Fifty-eight wounds of the parietal showed twenty-seven deaths and thirty-one recoveries. The occipital bone was penetrated twenty-three times, with sixteen deaths and seven recoveries. The temporal bones were penetrated in thirty-one cases, with twelve deaths and nineteen recoveries. Orbital wounds were very fatal, only one recovery taking place out of eighteen cases. Four deaths took place out of five cases of penetration of the sphenoid bone. I admit that a penetrating wound of any special cranial bone does not exclude injury of portions of the encephalon far distant from that immediately subjacent to the perforation of the skull, yet, as in many cases the foreign body was removed, only the brain contiguous to the point of penetration must have been compromised, and I therefore consider Dr. Wharton's analysis of considerable value in determining the relative mortality of wounds of different parts of the brain. Indeed, it is only in accord with what the physiology of the different portions of the encephalon would indicate.

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[1] Gross, op. cit., vol. ii. p. 73.

[2] Phila. Med. Times, 1879.

[3] Drinking, mental excitement, or slight injury caused seven deaths among the fatal cases in Dr. Wharton's table.

Treatment.—From what has been said as to the increased chances of recovery, and as to its completeness, after removal of foreign bodies lodged in the brain, when contrasted with the results of non-interference, it must be clear that whenever an extraneous substance can be removed without too much destruction of tissue, it should be done. The difficulty of locating a foreign body in the brain is very great, owing to the ease with which the probe gets out of the track of the vulnerating body by penetrating the healthy cerebral substance. Great care should therefore be exercised in the use of the ordinary probe. A soft—not flexible—catheter may be used with comparative safety; by resorting to this instrument, Larrey successfully detected and removed bullets in the two following cases.

A soldier received a musket-ball wound in the middle of the frontal bone near the sinus, which passed between the cranium and the dura mater, and along the longitudinal sinus to the occipital suture. It produced all the symptoms of compression. Larrey, inferring the location of the ball from the patient's complaints of pain at a point diametrically opposite to the wound, introduced a gum-elastic sound until he touched the bullet. By measurement, the portion of the cranium beneath which the ball lay was exposed, a large trephine was applied, pus was evacuated, the ball was removed from between the dura mater and brain, and recovery ensued.[1]

A ball penetrated the left parietal eminence of a soldier, passed obliquely along its inner surface, and was arrested about one centimetre from the occipital suture. The presence of a slight ecchymosis near this spot, the symptoms, and the employment of a small soft sound, induced Larrey to lay bare the bone, when he found a small fissure, applied a large trephine, and removed a piece of the bullet. The patient did well for five days, and then died of a fever.[2]

Now of course I do not advise the surgeon in every case of lodgment of a foreign body in the brain, to imitate Larrey, but I simply relate the cases to show what skill, boldness, and good fortune will sometimes effect, and to prove that apparently perforating wounds of the brain itself may be only so in seeming, so that a careful examination in suspected cases may reveal a more favorable condition admitting of operative interference, which may turn the scale towards the side of recovery. As already remarked, a silver probe should be used, if at all, with the utmost care; it is better to resort to a small, soft rubber, or French, sound or catheter, and even with such an instrument, to examine with judgment, and not make persistent efforts to locate the foreign body, since patients may recover with permanent lodgment of extraneous substances. For the methods of extracting such objects, I would refer the reader to the section on trephining.

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[1] Op. cit., vol. i. p. 307.

[2] Ibid., vol. ii. p. 170.

PACHYMENINGITIS, ARACHNITIS, AND CEREBRITIS.—Any injury of the head may give rise to intracranial inflammation, but some are more apt to produce such an untoward result than others. Thus, lesions of the brain-substance are more frequently followed by inflammation than scalp-wounds and injuries of the bones. When intracranial inflammation arises from a scalp-wound, where the vulnerating body has injured none of the cranial contents, it is always due to a complicating erysipelas or diffuse cellulitis. Under these circumstances, cerebral symptoms not uncommonly manifest themselves. The post-mortem examination of cases fatal from such complications, usually reveals nothing beyond an increased vascularity of the pia mater, with effusion of opaque fluid in the subarachnoid tissue over the upper surfaces of the hemispheres, and marked congestion of the cerebral substance itself.

When the disease starts in the bone or its coverings, the inflammation spreads inwards, first involving the dura mater, then the parietal arachnoid, the visceral arachnoid, next the pia mater, and finally the cortex of the brain. Examining the different tissues involved, it will usually be found that, in the acute forms, especially in those arising from osteo-myelitis after bone injury, the dura mater becomes infiltrated, and its outer surface smeared with lymph or pus; it may even slough. Although the inflammation, as far as the dura mater is concerned, is almost invariably confined to that portion of the membrane which lies immediately beneath the diseased bone, yet this is not always the case, as it tends in exceptional instances to spread along the cellular coat of the meningeal arteries until the disease reaches even the base of the skull.

When inflammation of the dura mater results from chronic mischief set up by traumatic osteitis, caries, or necrosis, the membrane is apt to be thickened, more vascular, and closely adherent to the bone. Rokitansky states that under these circumstances either bony plates may be developed, which become fused with the cranial bones, or osseous concretions may be formed in the dura mater itself, which often in time co-ossify with the adjacent part of the skull.[1] As the parietal arachnoid is, histologically, really a part of the dura mater, in the acuter cases the inflammation soon involves the former tissue, when the disease usually becomes rapidly widespread. This is the rule, but Hewett relates one case where the effusion of pus and lymph upon the arachnoid was exactly limited to the diseased area of the dura mater.

Traumatic arachnitis, as it usually appears, involves the upper and lateral surfaces of both hemispheres, although only the surface of that which corresponds to the bone injury may be affected. Sometimes the surfaces of both hemispheres may be involved without any effusion at the base of the skull. In the majority of cases the arachnoid cavity contains a large amount of a yellowish, or greenish-yellow, fibrinous, or purulent exudation. In rare instances adhesions take place between the opposite lymph-coated surfaces, and the purulent matter becomes circumscribed, forming an apparent cerebral abscess. Thus De la Peyronie,[2] Soulier,[3] and others have reported cases where the pus extended alongside the falx as low down as the corpus callosum. S. W. Gross has collected a number of cases where circumscription of the arachnoid effusion has taken place.[1] Hewett says that he has seen at an autopsy one case where the pus was thus circumscribed, the fluid running down between the falx and left hemisphere as far as the corpus callosum.

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[1] Rokitansky, Manual of Pathological Anatomy (Sydenham Society's edition), vol. iii. pp. 324-326.

[2] Œuvres de Sabatier, tome ii. p. 452. 1796.

[3] Mém. de l'Acad. Roy. de Chir., tome i. pp. 210. Paris, 1743.

The next tissue attacked is the pia mater, which is usually extensively infiltrated with the same greenish-yellow, puriform or plastic exudation that I have described as occupying the arachnoid sac. In one very severe case, the pia mater had become so thickened that it could be removed "whole from the brain, and with its prolongations, which dipped down between the convolutions," looked "as if it had been cast in wax."[2] The inflammation is usually limited to the pia mater of the convexity of the hemispheres, although this is not an invariable rule. The subjacent cortical brain-tissue is frequently dark and discolored, and so softened as oftentimes to permit adherent fragments of brain-substance to come away with the pia mater, even when the latter is removed with the utmost care.[3] The whole thickness of the cortical portion of the brain may be involved, or only a thin stratum of its periphery, while the white substance is entirely unaffected except by simple congestion, as evidenced by the larger size and greater number of its vascular puncta.

As exceptional conditions found after death from meningitis resulting from injury of the skull or its coverings, I may mention that, with pus between the bone and dura mater, the arachnoid sac upon the side of injury has been seen to contain purulent lymph, covering the posterior third of the upper and lateral surface of the hemisphere, with entire absence of subarachnoid effusion.[4] This is a very uncommon condition. In another case, with the dura mater covered with adherent lymph, and "matter running from thence along the branches of the middle meningeal artery down to the base of the skull, no effusion was found in the arachnoid cavity," while seropurulent fluid was found in large quantities in the subarachnoid tissues covering the whole of the corresponding hemisphere.[5]

I would here call attention to the interesting fact that, while it is the rule to find inflammatory effusions in the arachnoid sac when the disease is due to traumatism of the bone, meningitis from brain injury resembles the idiopathic form of inflammation, in that the arachnoid cavity is in the majority of cases free from effusion.

If the morbid appearances of the membranes after contusion[6] of the brain be examined, the exudation will be found chiefly if not entirely in the pia mater, which it infiltrates to a varying extent. In those cases alone in which the inflammatory process is of an exceptionally high grade, does the effusion take place into the arachnoid cavity. When purulent, the effusion into the pia mater is not infrequently of a decidedly green color.

There are then two kinds of traumatic inflammation of the meninges, in which the primary source of the disease affects first the membranes nearest to it. Thus, when the bone is the starting point, the dura mater becomes affected, and, as a consequence almost without exception, the free surface of the arachnoid. Originating in the cerebral substance, the inflammation attacks the pia mater, to which it is confined, except when the morbid process is very severe.[7] Owing to the visceral arachnoid in many parts having a covering of endothelial cells upon the surface next to the brain, the relations of this membrane to its subjacent connective tissue differ from those of any other serous membrane, a difference which probably accounts for the peculiarities of limitation of inflammation just described.

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[1] Am. Jour. of Med. Sci., vol. lxvi. p. 63. 1873.

[2] There will be found in Holmes's System of Surgery, 3d ed., vol. i. p. 620, a cut which shows the appearances described. See also Rokitansky, op. cit.

[3] Rokitansky, op. cit., vol. iii. p. 342.

[4] Hewett, op. cit., vol. i. p. 620; Watson, Practice of Physic, 4th ed., vol. i. pp. 377, 378.

[5] Hewett, op. cit., vol. i. p. 621.

[6] Many such cases would be called concussion by the majority of surgeons.

[7] The intense cerebral congestion mentioned as having been found soon after concussion, readily explains the readiness with which the pia mater becomes inflamed after such accidents.

Accumulations of perfectly clear, or slightly turbid serum, sometimes take place in the ventricles after head injuries. They generally coexist with inflammation of the membranes. Again, these effusions may take place slowly, when the head symptoms will be long delayed, and will probably concern the physician rather than the surgeon. When, however, the effusion takes place rapidly, with a scalp wound and bare bone, as in a case reported by Hewett, an error in diagnosis is very liable to occur, and the trephine may be resorted to with the expectation of evacuating pus between the dura mater and bone.

A middle-aged man received a scalp-wound by a fall in the street, which did not denude the bone. After prolonged collapse he reacted, and had most furious delirium, requiring restraint. The day before he had had, for the first time in his life, some kind of convulsive fit, but unattended with frothing at the mouth. The day following he complained of violent pain in the head, which persisted despite of treatment until the sixth day, when the scalp-wound became œdematous, and the bone denuded. Early in the morning of the seventh day the man suddenly began to hiccough, and became completely comatose, with normally acting pupils, a feeble, running pulse, and no stertor in respiration. A trephine was applied, after consultation, over the exposed bone, with the hope of evacuating matter from between the skull and dura mater; none was found, both the membrane and bone being healthy. The patient died unrelieved the same evening. Some serous effusion was found in the subarachnoid tissue, especially at the base of the brain, but the membranes were normal, and the pia mater was not congested. The ventricles were dilated, being filled with a large amount of serum, and the cerebral tissue was œdematous and softened. A small tubercular deposit was found in one of the cerebral convolutions of the base, but elsewhere none others were discovered, while all the organs of the trunk were normal.[1]

This case bears out the advice which I have given with regard to trephining for intracranial suppuration; there were no pressure signs to warrant the belief that operation could afford relief.

Cerebritis.—As we have just seen, the cortical substance may be affected in inflammations which have reached the pia mater from whatever source. This form of cerebritis, however, is probably secondary to meningitis. In some cases of concussion, without laceration of the brain or ecchymosis into its substance, I have said that intense, general congestion may result. In such cases a cortical cerebritis supervenes, which we occasionally have an opportunity to investigate. I say occasionally, since simple concussion rarely produces a fatal inflammation. In the early stages of this form of cerebritis, the gray matter is swollen, soft, and of a dark-red color, and covered by a markedly congested pia mater, which, when stripped off, is apt to bring away softened portions of brain-tissue. At a later period, exudation takes place into the pia mater, and the dark cortical substance is so softened that it readily washes away under a gentle stream of water, leaving the white matter bare, much congested, but not softened. The extent of implication of the brain-cortex is variable, but it may even occupy a whole hemisphere, except the base, which in most cases is unaffected.

Brain-contusion and brain-laceration are the most common causes of traumatic cerebritis, and this can be detected should the patient survive for only a few hours. The first change noticed is a congestion of the brain, which implicates its whole structure, but is most marked about the injured spot or spots. Next the cerebral tissue around the contusions assumes a darker hue, and becomes œdematous, swollen, and softened. Soon inflammatory effusions take place, which reduce the brain-substance to a variously tinted, soft, pulpy, or diffluent mass, readily washing away under a gentle stream of water. The portions of brain around the softened area are altered to a less extent, appearing disintegrated and shreddy. Although these changes are commonly limited to the neighborhood of the original injury, the greater part of an entire hemisphere sometimes becomes involved, when the white substance is apt to be of a "peculiar saffron-color" (Hewett) at the centre of intensity of the morbid process, the tissue being soft and diffluent.[1]

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[1] Hewett, op. cit., vol. i. p. 623.

A few drops or a gentle stream of water should be allowed to fall upon all suspected spots, as at times the marked disintegration undergone by the brain substance is not at first plainly perceptible. The yellow color is due to the large number of pus corpuscles and cells in a state of fatty degeneration, and possibly also to the remains of blood effused from the original injury, or more recently from the rupture of small vessels.

When the inflammation is limited, an abscess may result, proliferation of the surrounding neuroglia forming in some cases a thickened fibrous wall; under which circumstances the malady may remain quiescent for a long time.

A recent abscess consists of a rounded, irregularly-shaped cavity in the brain-substance, with walls formed of suppurating cerebral tissue, shreds of which, soaked in pus, hang into the cavity. The surrounding brain is in a state of inflammatory red softening, contiguous to which the cerebral substance is œdematous, while in many cases around the area of red inflammation is a zone of yellow softening. The contained pus is thick and greenish, and sometimes has an extremely offensive odor.[2] Cerebral abscess most commonly results from contusion and laceration of the brain-substance, but may arise from so-called simple concussion. Like collections of pus in other organs, it has a tendency to extend at its periphery, although it may burrow sinus-like in various directions. When it ruptures into one of the ventricles, death rapidly ensues. Various cases have been reported in which the pus from cerebral abscesses has found its way, by ulceration through the bones, into the nasal fossæ or ear, recovery having ensued. The amount of pus and the suddenness of its discharge have been the arguments chiefly relied upon to prove the cerebral origin of these abscesses, when recovery has taken place. I have no doubt myself that some of these have been really cases of circumscribed intrameningeal accumulation, although in a few, post-mortem examination has demonstrated their cerebral origin.

Symptoms of Intra-cranial Inflammation.—The symptoms of intracranial inflammation will be first considered as a whole, and then an endeavor will be made to point out those special symptoms which may be of use in determining which of the various intracranial structures is chiefly diseased. My reason for treating the subject in this manner, is that I do not believe it to be possible to determine positively whether in one case the membranes alone are inflamed, or whether in another the brain is solely involved.

The first symptom commonly noticed is headache, which may be either slight or severe, may be confined to the seat of the blow, or may extend from that point over the whole head. Dizziness, vertigo, tinnitus aurium, flushed face and suffused eyes, coated tongue, and anorexia are commonly observed. The pupils are contracted and abnormally sensitive to light, and there is intolerance of sound. Fever, with hot, dry skin, and a rapid, hard pulse, accompany these cerebral symptoms. All the symptoms increase in severity with the advance of the intracranial inflammation, and soon nausea, vomiting, obstinate constipation, restlessness, constant jactitation, delirium, and convulsions—one or all—mark the progress of the case. Then, as the inflammatory effusions are poured out, symptoms of irritation or pressure begin to manifest themselves. Drowsiness, dilatation of one or both pupils, oscillation of the eyeballs, irregular twitchings or even spasms of the muscles, steadily increasing coma, stertorous, puffing respiration, a slow, full pulse, incontinence of feces and urine—the result of paresis of the sphincters—paralysis, and death, too commonly succeed one another. Where the pressure-symptoms are due to the formation of pus, more or less marked chilliness, or rigors, are apt to precede the signs of compression. If cerebral abscess forms, the temperature will be usually subnormal, either at the outset only, or continuously until the pus is evacuated, when it will probably suddenly rise.

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[1] This is the yellow softening already referred to on page 70.

[2] Rokitansky, op. cit., p. 413.

While typical cases present most, if not all, of the symptoms detailed, and commonly in the order given, in many instances they vary markedly. So dissimilar from the standard given in text-books are many cases met with in practice, that the diagnosis of intracranial inflammation is oftentimes a most puzzling affair to the tyro, and may sometimes even baffle the expert. Although it may be impossible positively to assert, in any case of head-injury, that the symptoms proceed from an inflammation of the brain-substance and the visceral layers of the meninges, the result of concussion—or that they are due to contusion and subsequent inflammation of the bone and the subjacent dura mater, with the parietal arachnoid—yet attentive study of the time of onset of cerebral symptoms often enables the surgeon to determine where the inflammation has started, and therefore the structures which are most likely to be chiefly involved. A post-mortem examination will, indeed, often disprove the opinion thus formed, but in many cases it will verify the accuracy of the inferences founded upon the time of onset of the symptoms.

From the intense congestion of the cerebral mass, with its investing pia mater, which results from *concussion*, we should expect the early onset of signs of inflammatory mischief; and accordingly we find that in many cases the symptoms begin within a few hours.

Four or five days usually elapse before symptoms of cerebritis declare themselves after *contusion or laceration* of the brain-substance, and until this time a most deceptive calm, with an apparent entire absence of any mischief resulting from the injury, is apt to prevail.

Inflammation consequent upon *contusion of bone* may appear early, as in a number of Pott's cases, but it is far more apt to "smoulder," as has been said, for two or three weeks, and then to suddenly burst forth.

The symptoms of *cerebral abscess* are not usually pronounced until about the twenty-fifth day upon the average, although I have seen them within two weeks of the injury.

Convulsions are a most uncertain symptom, especially in the young. When occurring immediately after the injury, they are certainly not due to inflammation. Again, they may appear just about the time when intracranial inflammation is to be expected, leading to the supposition that encephalitis has commenced, when nothing of the sort exists. Being simply indicative of irritation of the cerebrum, of its membranes, or of all these structures, convulsions are produced by too many varied causes to be of any particular value as a means of diagnosis in intracranial inflammations.

Treatment.—I place in the first rank as to importance, prophylaxis. As has been, I trust, made clear, there is a variety of meningitis arising directly from the intense congestion of the brain and its membranes which results from concussion, even without any cerebral contusion, and this inflammation sets in very early, sometimes even within a few hours. I am, therefore, in the habit, in cases of concussion, unless the patient has lost much blood, or is from any cause peculiarly feeble, of directing that the strictest antiphlogistic regimen shall be pursued for the first forty-eight hours, that is to say, that nothing but water shall be allowed. Dry cold should be applied to the head, which should be shaved if the case be a bad one. The room must be darkened and the head kept slightly elevated. A calomel purge, followed by a saline, should be at once administered. After the first forty-eight hours, or from the outset if the patient be feeble or have lost much blood, a milk diet must be substituted for the starvation plan, lest suppuration should be favored by depression of the bodily powers. I prefer, however, that the smallest quantity of milk compatible with supporting the patient's strength should be indulged in until after the fifth or sixth day, that is, until after the usual time of onset of intracranial inflammation. I know that with many this system of treatment is out of vogue, but when judiciously resorted to, I am satisfied that it is the safest course to pursue, and on this plan I have treated a number of severe head-injuries without anything indicating that I had better have resorted to other measures. Upon the other hand, an increase of diet has been followed over and over again by vertigo, increased headache, and fever, all of which symptoms have spontaneously subsided upon returning to a more meagre allowance.

At the first onset of pronounced cerebral inflammation, in very vigorous patients, venesection may be resorted to in just sufficient quantity to sensibly affect the pulse. I prefer, however, to rely upon wet-cupping or leeching, without venesection, and, should the latter have been resorted to at first, wet cups to the nape of the neck should be used if occasion arise for the further abstraction of blood. I am persuaded that free cupping cannot fail to be of decided benefit in many of the cases which are received into our large hospitals. The system should be as rapidly as possible gotten under the influence of mercury, and to this end one-fourth of a grain of the mild chloride, combined with an equal amount of opium,[1] should be exhibited every two hours. Should the system prove rebellious, mercurial inunctions may be used as adjuvants. When the abstraction of blood is thought inadmissible at the outset, or when no longer considered advisable, free and frequent purgings are indicated, always remembering that the patient under treatment is to be considered, not as a supposititious "case" of encephalitis for which such and such remedies have been recommended, but as a person whose condition varies from day to day, nay, from hour to hour.

Intermittent compression of the carotids has been recommended by Neudörfer, Vanzetti, and others, and where practicable it might be tried, as it should theoretically prove beneficial.

Sleeplessness, or the furious delirium which occasionally supervenes within the first few days after a head-injury, must be relieved by the cautious use of opium. I cannot enter into theoretical reasons why opium is not harmful in head-injuries, as is so often contended. I only know that I do not hesitate to use it when it appears indicated, and that so far, in common with the most experienced surgeons, I have seen nothing but good result from its employment. By quieting the heart's action, less blood is sent to the brain, the mind is set at rest during sleep, and nervous fret and worry are relieved. Opium in some way unquestionably causes contraction of the peripheral capillaries; why should it not then similarly affect those of the brain? When the heart's action is strong and frequent, aconite and veratrum viride may be found useful, either with or without the opium. Chloral and the bromides, as supplementary to opium, or to replace it, will prove useful in cases of excessive wakefulness, and where there is a marked tendency to convulsions.

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[1] If this amount of opium should produce too much drowsiness, or stupor, especially in the case of children, it must, of course, be diminished.

The condition of the kidneys as to prior renal disease should be investigated, as otherwise we may confound cerebral symptoms of renal origin with those due to traumatism.

What testimony does experience give as to the results of antiphlogistic treatment? In our late war, where it was not considered essential, Otis states that four-fifths of the cases of injury to the skull and its contents proved fatal, while the British surgeons in the Crimean War, and the German surgeons in 1849–50, saved more than one-half. To be sure, the more universal adoption of rifled weapons may make this difference in reality less than it seems, but it cannot account for the entire discrepancy.

Should blisters or other forms of counter-irritation be used? I think not, and certainly only late in the disease.

Suppose that the case does well, when must the antiphlogistic measures be exchanged for a more ordinary diet and treatment? This must be left to the surgeon's judgment in each special case. I know nothing much harder to decide than, at the bedside of a patient with serious head-injury, to correctly indicate when a resort to a more liberal diet should be initiated. Of course, when the patient is manifestly becoming rapidly exhausted, the question is simple enough. It is in those cases which are doing well, with apparently not much amiss with them, that errors arise. No sudden change should be allowed, but a more generous dietary may be tentatively instituted. Stimulants even are required in some cases, but here I prefer digitalis, to improve the power of the heart, or ammonia in some form, rather than alcohol.

Having gotten the system under the mercurial influence, the calomel must be omitted, or given at longer intervals. In the later stages, iodide of potassium and ergot have proved serviceable in my hands.

In the later and more insidious forms of traumatic encephalitis, to which the terms subacute or chronic may be applied, where the patient, after some slight injury, persists in attending to work and business, until slight headache, mental irritability, constipation, broken sleep, vertigo, and fever set in, to be followed by delirium, etc., the treatment does not materially differ from that already indicated, except that depletion is less well borne, and that mercurial purgatives and a more generous diet seem rather indicated than a strict antiphlogistic regimen.

After any attack of intracranial inflammation, the patient must regard himself as an invalid for a long period, entirely abstaining from work or only gradually returning to it, and at once relinquishing it upon the slightest sign of cerebral irritability.

Cerebral Abscess.—So grave does any operation for intracranial abscess appear to the public, that many surgeons allow themselves to be influenced by the fear of blame should death result, and are too apt to confound the great fatality inherent in the disease itself, with that of the operation destined for its relief. A calm consideration of the natural history of the affection in question, will, I believe, show that, when accessible, these depots of pus should be treated upon the same principles that govern us in dealing with circumscribed suppurations elsewhere. Are such collections of pus, even in the arachnoid cavity, ever absorbed? There is no such case on record. What do autopsies teach us with regard to abscesses of the cerebral substance? That in the vast majority of cases they enlarge, by involving more and more of the brain at their periphery,[1] until they either by pressure[2] induce fatal trouble, or by bursting into the ventricles rapidly destroy life.[3] In some few cases the surrounding proliferating neuroglia is finally organized into a firm sac-wall, and the disease remains stationary for a time, but only stationary—not cured.[4] In a few of these cases, post-mortem appearances would seem to indicate that caseation of the contents of a former brain-abscess had taken place, and that recovery by partial or complete absorption was therefore possible. Such an occurrence must be exceedingly rare, and I doubt if it ever takes place in traumatic cases, where the surrounding cerebral substance, instead of being condensed, is more apt to be softened. Sooner or later, such quiescent abscesses will terminate life, and that, too, very suddenly in most cases. A still further study of the natural history of cerebral abscess will give us, I think, some valuable therapeutic hints. Among the greatest of surgical rarities is the spontaneous evacuation of a cerebral abscess, either through the nares, orbit, or external auditory meatus.[5] This can only take place when the suppurating cavity lies near such portions of the skull as the cribriform plate of the ethmoid, the roof of the orbit, or the tegmen tympani. Such was the case in a patient who was under the care of Mr. C. Hawkins, and an abstract of whose history I here subjoin:—

A man twenty-eight years of age, three weeks before his admission into hospital, struck his head violently against the edge of a door, producing a small wound on the right side of the forehead, with much ecchymosis, with but little external hemorrhage. There was intense pain at the seat of the blow. A week afterwards, headache and delirium came on. A discharge from the left ear of many years' duration, which had before stopped running from time to time, when marked deafness was always noticed, now ceased. The pulse was frequent and weak, but there was no more pain upon the left side of the head than upon the right side. Two days subsequently the pulse was "laboring" (I presume slow and full). The patient became comatose, and died the next day. After death, an abscess with softened, ragged walls was found in the left anterior and middle lobes of the cerebrum, containing about three ounces of pus. The dura mater was adherent to the roof of the tympanum, and through the necrosed bone a small probe could be passed into the middle ear, which showed evidences of chronic otitis with destruction of the membrana tympani.[6]

This abscess was clearly secondary to the old otitis, and the blow probably set up active disease in the adherent and diseased dura mater overlying the chronically inflamed middle ear. Other similar cases, where recovery has ensued, might be quoted if it were necessary, to demonstrate that nature can and does successfully evacuate cerebral abscesses.[7] The next link in my chain of argument is, that after an unsuccessful attempt had been made to discover pus in certain cases, and when the trephine had revealed a healthy, non-bulging, pulsatile condition of the dura mater, this membrane was nevertheless incised, and in a few hours or days nature ruptured the superjacent brain-substance, and, the pus having escaped externally, recovery ensued. Here, as elsewhere, a brief account of a few selected cases will convey my idea better than a mere general description:—

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[1] By a rapidly progressing yellow softening in many instances.

[2] Acute œdema of the brain is frequently the immediate cause of death. Chronic internal hydrocephalus is common in cerebellar abscess, whenever it tends to lessen the cavity of the fourth ventricle, or to compress the aqueduct of Sylvius. (See Ziemssen's Cyclopædia of Practical Medicine, vol. xii.)

[3] Abscesses situated in the middle of the parietal and frontal lobes open usually into the ventricles. Those of the middle lobe may open at the base of the brain, giving rise to a most fatal form of meningitis.

[4] Meyer (Ziemssen's Cyclopædia of Practical Medicine, vol. xii.) has shown that, although as reported by Lallemand, a capsuled brain-abscess may be met with as early as the thirteenth day, a distinct abscess-wall is upon the average not seen before seven weeks.

[5] Perforation through the orbit, the temporal bone, and other portions of the skull-bones, after agglutination of the membranes, has been reported. If adhesions do not form, a widespread fatal meningitis is apt to occur when nature strives to spontaneously evacuate these abscesses.

[6] London Medical Gazette, First series, vol. xvii. p. 156.

[7] Tassi, Proceedings of the Royal Academy of Medicine of Rome, quoted in the Lancet, April 26, 1884; Hawkins, loc. cit., p. 162.

A child nine years old, suffering from a compound depressed fracture of the frontal bone, was trephined by Petit. Headache and fever set in on the night of the fifth day, and on the following day the dura mater, distended and discolored, bulged into the opening. A tablespoonful of brown, fetid fluid was evacuated by incision of the dura mater, but the symptoms steadily increased up to the night of the eleventh day, when rapid improvement occurred, and it was found that a large abscess had burst and saturated the dressings with offensive matter. Complete recovery ensued in two months.[1]

Dr. Joseph Pancoast trephined in a case where the altered dura mater puffed up through the trephine-opening. Incising this, allowed the softened brain-substance to pout through the wound. Urgent symptoms being absent, although a sensation of distinct fluctuation was felt, nothing further was done. The abscess opened spontaneously next day, and the patient improved for two weeks, more or less pus being constantly discharged. On the sixteenth day, owing to obstruction to the flow of pus—as was proved by an autopsy—death resulted. The abscess communicated with the posterior horn of the opposite ventricle.[2]

Acquaintance with these facts logically leads us a step further, and, an abscess of the brain-substance having been diagnosticated, an incision would seem indicated to evacuate the matter, just as it would be in a case of subcutaneous phlegmon. Examination of the records of our art shows that this practice has been repeatedly adopted. Thus among others I find the following apposite cases:—

An officer was struck by a pistol-ball, which grooved the outer table of the left frontal bone. Marked symptoms of encephalitis set in on the tenth day, but subsided under treatment. In consequence of excesses of diet, intense headache, rigors, etc., declared themselves upon the twenty-third day, followed in seventy-two hours by convulsions, aphasia, right hemiplegia, and coma. Upon the twenty-ninth day after injury, Surgeon J. F. Weeds trephined over the left frontal eminence, and found a small scale of the inner table lying loose upon the slightly lacerated dura mater. An incision was made into the substance of the brain, evacuating half an ounce of green, offensive pus, when the symptoms of compression disappeared in ten hours, and recovery ensued.[3]

Dupuytren had a patient who had been wounded by a knife-blade on the top of the head. The weapon broke off short in the bone, and the fragment was overlooked by the surgeon who first dressed the wound. This healed, and no trouble, save occasional pains about the scar, followed for over two years, when the man suddenly became unconscious, and in that condition was admitted into the Hôtel-Dieu. Examination of the old scar and subsequent incision revealed the point of the knife imbedded in the bone. He was trephined without relief, and opposite hemiplegia made its appearance. Incision of the dura mater revealing nothing, Dupuytren plunged his knife deeply into the brain, whereby a large quantity of pus was evacuated; the symptoms disappeared, and the patient ultimately recovered.[4]

Upon the other hand, an equally favorable opportunity for surgical interference presented itself to De la Peyronie, but was lost; and with it the patient's life, by the declination of further operative interference after the dura mater had been incised without discovering pus. In this case, the autopsy revealed an abscess immediately below the trephine-opening, only three or four lines beneath the surface.[5]

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[1] J. L. Petit, op. cit., p. 354.

[2] Treatise on Operative Surgery, 2d ed., p. 106.

[3] Nashville Journal of Medicine and Surgery, April, 1872.

[4] Leçons Orales, 2e éd., tome vi. p. 146.

[5] Mémoires de l'Académie Royale de Chirurgie, tome i. p. 319. Paris, 1743.

Finally, let me illustrate by my own practice and that of others, what I believe to be the proper treatment in cerebral abscess:—

On the morning of March 6, 1884, J. Y., aged nineteen years, walked into the Episcopal Hospital, complaining of a sore on the top of his head. He said that it was the result of a blow which he had received two months previously at Chicago. On examining the wound, an ulcer was found located about the position of the left middle parietal lobe. In the centre of this ulcer was the broken edge of a knife-blade. Upon being told of this, he seemed thoroughly surprised that such was the case. But little could be made out by closely questioning him as regarded the incidents of the attack, except that a man had struck him on the top of the head so forcibly that he had fallen on his hands and knees, but had recovered himself almost immediately. He said that he did not at that time, nor afterwards, lose consciousness, nor had he had even a headache. All symptoms of brain-injury were absent. He did not complain of any pain or uncomfortable sensation when the knife-blade was removed by the gentleman who first saw him; but in the afternoon of the same day he had slight pain in the head. His appetite was good, and his bowels constipated. March 7, patient had rested well through the night; did not complain of headache. Temp. 100° F.; pulse 80.

An examination of the eyes was made by Dr. Heyl, five hours after the withdrawal of the knife-blade, with the following result:—

Pupils reacted normally to incident light. Media and optic papilla normal. Retinal arteries of full size in the left eye, probably also in the right eye. It was difficult to pronounce positively on this point, owing to the peculiar distribution of the vessels. Veins in both retinæ enlarged and of a black color. Arteries and veins in each eye tortuous. Very many fine, thread-like reflections of light, doubtless from very fine vessels. Diagnosis was retinal hyperæmia, arising from intracranial circulatory disturbance.

March 8, temp. 100° F.; pulse 80. This afternoon, at one P. M., after the wound had been examined, he was seized with an epileptiform convulsion which lasted about two minutes; no particular movements were made which could lead to the localization of the source of irritation. At four P. M. he had another attack, but not as severe as the first, being conscious during the paroxysm. At ten P. M. a very violent convulsion occurred, the patient remaining unconscious five minutes. The attack began with a twitching of the right arm, but soon became general. Having been sent for, I trephined the skull over the seat of injury, removing a button of bone which showed a slight depression of the inner table. The position which the blade had occupied could be seen in the dura mater, there being an opening surrounded with dense cicatricial tissue. The dura mater did not seem to be congested, and there was evidently no pus or fluid beneath it. The wound was washed out with a solution of corrosive sublimate, one part to two thousand, and then dressed with sublimated gauze.

March 9, temp. 100° F.; pulse 83. The patient seemed easy this morning, except for slight pain about the wound. At 11 A. M. he was seized with a muscular tremor of the lower extremities. He was conscious during the attack, but could not control the movements, which lasted about three minutes.

March 10, temp. 100° F.; pulse 80. Doing well this morning, no headache.

March 14, temp. 98° F.; pulse 62. The wound is looking well; moderate, healthy suppuration. Patient's general condition is worse. Marked hebetude and slow pulse. He sleeps the greater part of the time. Brain-abscess suspected.

March 17, temp. 102° F.; pulse 67. This morning an erysipelatous blush is noticed over the forehead, but not about the wound. The attack lasted until the 21st, being limited to the face and yielding easily to treatment.

March 22, temp. 98½° F.; pulse 76. Patient's condition is still worse. The tongue is coated, dry, and fissured. Pulse slower, and memory failing.

March 25, morning and evening temp. 98° F.; pulse 60.

March 26, temp. 97½° F.; pulse 53.

March 27, morning temp. 97½° F.; evening temp. 98½° F.; pulse 70.

March 29, the patient's condition is about the same; incontinence of urine; hebetude more marked. Pulse 52; morning temperature 99° F.

March 30, temperature 99° F.; pulse 70. This morning I found the patient unconscious, and with right-sided hemiplegia; he was rapidly sinking.

The symptoms of brain-pressure being so marked, immediately upon my arrival I reflected the flap covering the trephine-hole, and found it filled by the tensely stretched dura mater, which, however, pulsated strongly at every portion. A feeling as of fluctuation was conveyed to the finger. While examining the wound, a minute drop of pus, not larger than a small pin-head, oozed up through the dura mater. Supposing that the cause of the trouble was reached, I made a small incision through that membrane, but, to my disappointment, nothing was evacuated. Further manipulation brought about half a minim of pus, which was thought to come, perhaps, from a diffused layer of pus in the arachnoid cavity. The coma rapidly deepening, an aspirator-needle connected with a vacuum was passed in at least three, if not four different spots, to the depth of two-thirds of an inch, but with no result. Feeling convinced that pus was present, and that from the symptoms it was compressing the ascending frontal and parietal convolutions, I proceeded to set a large crowned-trephine in front of, and below the first opening, which was slightly behind the fissure of Rolando, according to my calculations. Before I had more than half divided the skull, both pulse and respiration ceased, and the patient was thought to be dead, by both my colleague Dr. Morris J. Lewis, the three resident physicians, and myself. After laying the instruments aside for a moment, I determined to complete the operation. Rapidly dividing the bone, I found an apparently normal dura mater, which I incised, but found nothing. While Dr. Lewis and I were examining the exposed membrane, a large drop of pus oozed up through one of the aspirator-punctures. I at once plunged a knife into the brain-substance, and evacuated from one to two fluidounces of greenish pus. The patient appeared to be quite dead, but placing my hand over his heart I thought, but was not sure, that I felt a feeble cardiac pulsation. Dr. Lewis immediately seized the patient's arms and began to practise artificial respiration. In about half a minute his skilful efforts were rewarded by a gasp, and then the diaphragm feebly contracted. I then sent for the battery, which was effectively used by Dr. J. K. Mitchell; one-hundredth of a grain of atropia was subcutaneously injected; sinapisms were applied over the heart; a turpentine enema was administered; warmth was applied to the feet, etc. After some twenty minutes' vigorous treatment, the intercostal muscles commenced to act slightly, but, on the cessation of efforts at artificial respiration, in a few moments the patient ceased to breathe. Renewed efforts resuscitated him. In two hours' time he was semi-conscious, and could feebly move his right arm. All pulse and respiration had ceased, at the lowest computation, for fully three minutes.

March 31, temp. 97½° F.; pulse 120. Patient much better, and conscious. An ophthalmoscopic examination was made to-day by Dr. Heyl. Left pupil a little sluggish in its reaction to light. Right pupil normal. Margin of each papilla absent. Retinal veins of large calibre, tortuous, and filled with very black blood. Arteries, if of abnormal calibre, are slightly diminished in size on the retina, but of normal calibre on the disks. The optic disks do not look swollen, as is commonly the case in papillitis, but as if they possessed the same level as adjoining parts of the retina. The refraction of the papilla and surrounding parts of the retina were not obtained. It is also noted that at the time of examination the patient's face is dusky, but that his mind seems clear. The diagnosis is double papillitis in the stage of retrogression. A hernia cerebri the size of a walnut is extruding from the wound in the dura. The abscess discharges freely. The patient does not complain of headache.

April 1, temp. 102° F.; pulse 110. Erysipelas again on forehead, extending over face. The hernia cerebri is now about the size of an egg. Patient is losing strength.

April 2, temp. 103° F.; pulse 112. Condition worse, hernia breaking down and coming away with poultices.

April 4. The patient died this morning at 6.30 A. M. He remained conscious until three hours before his death.

Autopsy.—About the position of injury, the dura mater was bound down to the brain by inflammatory adhesions. The left parietal lobe was an enormous abscess-cavity. The abscess was superficial, destroying the greater portion of the upper part of the left hemisphere. The right hemisphere moist; the dura congested. Old pleuritic adhesions were found in the chest; the lungs were affected with hypostatic congestion, but otherwise normal.

Mr. Hulke reports the following cases:—

A boy aged 13, whose forehead had been grazed by a push against an iron fence, was trephined by me seven weeks after the accident, incomplete hemiplegia having supervened. The graze had festered, healed slowly, and left a tender scar. From the time of the injury there had been more or less severe headache; and latterly nausea and retching. The pulse was unnaturally slow and the temperature subnormal. The trephine was put on at the site of the injury on the right of the middle line of the forehead. The outer table was found slightly starred, but the cracks did not reach the inner surface of the bone. The dura mater, which appeared to be healthy, bulged up tensely into the bone-hole An aspirator-trocar, connected with an exhausted syringe, was pushed through it, and when this had reached the depth of about one inch, greenish pus was drawn up. The abscess was then freely opened with a narrow scalpel, and a quantity of pus, estimated at from three to four fluidounces, escaped. The hemiplegia soon disappeared; the other symptoms less quickly. Optic neuritis supervened and ended in blindness. Several months afterwards, whilst in the blind school, the patient had epileptiform fits. He was kept in view during several years, and, when last seen, was a very intelligent, well grown youth.[1]

A laborer, aged about 60 years, was recently admitted into the Middlesex Hospital, under my care, a fortnight after being struck a glancing blow on the right temple by a falling ladder, which stunned him for a few minutes and caused a considerable bruise. He continued, nevertheless, to work as usual until the middle of the third day, when the headache which he had had from the time of the accident became very severe—so severe that his wife feared he would go out of his mind.

When taken into hospital he described the pain as darting from the seat of the blow (marked by a slight discoloration) through his head. The pulse was 56, and the temperature slightly below the normal average. His mind was unclouded. About one week afterwards, he became insensible in the night, and in the morning the right upper and lower limbs were found absolutely palsied as regarded motion, and nearly so as regarded sensation. When the right arm or thigh was severely pinched, he gave scarcely any sign of consciousness of it, but shrank slightly when the left arm or leg was pinched similarly. Two days subsequently, spastic rigidity of the left arm supervened. His wife, who had till now obstinately refused any surgical interference, permitted trephining. A small disk of bone beneath the bruised spot in the right temple was cut out. It appeared uninjured and healthy. The dura mater bulged up so tensely into the bone-hole that pulsation could neither be seen nor felt. The exposed surface of the membrane appeared healthy. An aspirator-needle, connected with an exhausting syringe, was pushed through it to a depth of about one and a quarter inches. A brownish, turbid fluid rose up into the receiver, and continued to flow through the prick-hole after the needle was withdrawn.

The minute opening was enlarged with the scalpel, and a considerable quantity of fluid escaped. The flaps which had been reflected were replaced, and the wound was very lightly dressed with a little boric charpie. An hour afterwards he asked for food. Next morning the spastic rigidity of the left arm had gone. On the second day slight return of power was noticed in the right limbs, and before the end of a week their palsy had disappeared. For a very few days after the operation, the charpie was wetted and discolored by the fluid which continued to ooze; but this oozing soon ceased, the wound soon healed, and two months from the date of the operation the patient appeared quite well.[2]

In some cases, even less operative interference may be necessary, owing to the sloughy condition of the dura mater and of the superjacent brain-substance. Thus Mr. Hulke gives the following account of a case under his charge:—

A middle-aged woman, having fallen down in a fit in a neighboring street, was brought to the Middlesex Hospital. She was unconscious, and her left arm and leg were rigidly flexed. On the right temple was a small festering wound, leading to necrosed bone. On perforating this with a trephine, several drachms of pus were forcibly ejected through a sloughy hole in the dura mater. The spastic rigidity of the left arm and leg immediately disappeared, but the patient soon died. At the examination of her body the empty cavity of a large abscess was found in the anterior lobe of the right cerebral hemisphere.[1]

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[1] Medico-Chirurg. Trans., vol. lxii. p. 367.

[2] Holmes's System of Surgery, 3d ed., vol i. p. 628.

Diagnosis of Cerebral Abscess.—As to diagnosis, I can only refer to the histories of the last cases which I have given. Mental hebetude, slow pulse, headache, perhaps rigors, subnormal temperature, constipation, and at the end sudden development of the symptoms of compression, as evidenced by profound coma, hemiplegia, respiratory failure, and death, seem to have, in all cases, marked the course of the brain-abscess.

I believe that an abscess involving the cerebral tissue alone, will be accompanied in most cases by a subnormal, or at least not an elevated temperature.[2] Where a high temperature is observed, either the pus-collection is simply a localized suppurative arachnitis, limited by adhesions, or there is a meningitis in addition to the abscess. If originating from bone-caries, middle-ear disease, etc., where the abscess is secondary, there is almost of necessity an elevated temperature, although even here, during the height of the symptoms, as in the last six days of life in a case reported by Huguenin,[3] the temperature may be normal.

If these observations are confirmed by others, a valuable diagnostic point will be afforded.

Can cerebral localization aid us in our diagnosis? I think that in cases where, after head injury, the patient presents the train of symptoms just detailed, with distinct implication of one or all portions of the motor area of one side, when death is imminent, even without external wound trephining and the use of the aspirator are at least warranted, if not demanded, in view of the success which has been obtained by their employment. If the motor area is not involved, or has not been primarily affected or injured, nothing beyond the purest chance could lead to a successful operation, with no bone-injury as a guide.[4]

Prognosis.—I do not presume to say that great success will attend operations for brain-abscess, but experience warrants the statement that every recorded recovery has been due to operation.

As in the great majority of cases, it is impossible at the time of operation to determine whether the abscess is located solely in the cerebral tissue, whether there is simply a localized collection of pus in the arachnoid sac, or whether the abscess-cavity consists partly of cerebral tissue and partly of the membranes, I shall quote the results of thirty cases, which will give an approximate idea of the chances of recovery in these affections. These cases have been reported by De la Peyronie, Dupuytren, Guthrie, Dumville, Noyes, Detmold, Ashhurst, Clark, Weeds, Holden, Hulke, Maunder, Tillaux, Lloyd, Chinault, Courvoisier, Stimson, Morehouse, Bontecou, Peck, Jalland, Elcan, Broca, Polaillon, Kilgarriff, Edmunds, Milford, W. D. Roberts, and myself. Of this number just one-half proved fatal. Of course I do not mean to say that fifty per cent. represents the actual mortality, but, as far as this series of cases goes, the results are encouraging.

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[1] Holmes's System of Surgery, 3d ed., vol. i. p. 626.

[2] See p. 27 of this article for a third case by Mr. Hulke, where the temperature was subnormal, making, with the following, five cases which I have noted as presenting this symptom. M. L. Brown reports a case of brain-abscess after fracture of the ethmoid bone, where the temperature was subnormal—97° F.—for eleven days. (Bost. Med. and Surg. Journ., Dec. 29, 1881, p. 610.)

[3] Ziemssen's Cyclopædia of Practical Medicine, vol. xii., page 735.

[4] See a case on p. 76 of this article, which I consider was eminently unfitted for operation, as perusal of its history will make clear.

Chronic Cerebral Abscess.—Although death after acute encephalitis may take place in the period of red softening and suppuration, consequent upon traumatisms of the brain, nearly all the cerebral symptoms may disappear, even while a chronic abscess is forming. During this latent period (which usually varies from one to two months, although it may be of only a few days' duration), when portions of the brain possessing definite functions are affected, symptoms of localized disease may be noticed, such as aphasia, paresis, or hemiplegia, and even convulsions, which are commonly general, but are more rarely limited to certain groups of muscles. Strabismus is very rare. Signs of constant, slight pressure upon the brain may sometimes be detected, such as more or less continuous headache, accompanied during the exacerbations by occasional slight fever, dizziness, and nausea. Violent headache probably means tension of the abscess, and congestion around it. The more frequent these attacks of severe cephalalgia, the more probable is it that acute red-inflammatory softening, yellow softening, and extensive cerebral œdema, are imminent; in other words, that death may take place at any moment. Occasionally dulness of the senses, slowness and want of motor energy, and gradual imbecility, accompany the chronic headache. Sleeplessness, optical delusions, and intermittent attacks of extreme terror have also been recorded. Again, after a rapidly developed, severe headache, the patient may become comatose and feverish, these symptoms lasting only for a few hours. Chills have been very rarely noted, but have been sometimes so marked as to give rise to the erroneous diagnosis of intermittent fever. Epileptiform convulsions often occur during the latent stage of chronic brain-abscess, but are in no way peculiar or diagnostic. The terminal processes of chronic cerebral abscess are, perforation outwards, with meningitis of the convexity of the brain; perforation at the base, with basal meningitis; rupture into the ventricles, extensive cerebral œdema, pressure upon the medulla oblongata by a cerebellar abscess, and remarkable anæmia of the brain. The symptoms attendant upon the last stages of brain-abscess are often those of mental irritation, restlessness, illusions, and violent delirium, with elevated temperature; but they are of such brief duration as to be frequently overlooked, and are followed by sopor, severe headache, slow pulse, dilated and feebly-acting pupils, depressed temperature, passive retinal congestion, occasional vomiting, complete coma, and involuntary evacuations. Hemiplegia—or more rarely other forms of paralysis—respiratory failure, and death usually result. Convulsions sometimes occur. Muscular contractures are at times noted. When perforation induces meningitis, a corresponding change and confusion of symptoms result, which I need not here attempt to describe. Cerebral localization may aid us in locating these abscesses, provided that they occupy certain positions. They—even more than acute abscesses—give rise to errors because of secondary involvement or irritation of contiguous or closely associated portions of the encephalon, whence errors can so readily arise that the greatest caution must be exercised in making up our final opinion.

I would refer the reader to Huguenin's excellent article on this subject in Ziemssen's Cyclopædia of Practical Medicine, for the differential diagnosis of chronic cerebral abscess, as my limits do not admit of my saying more than that intraocular ophthalmoscopic appearances and eye-symptoms are here unreliable, and that brain-tumor is the disease with which this affection is most apt to be confounded.

Cerebral Localization.

Whatever may be urged by the opponents of cerebral localization, I think that there will be few who will deny that the situation of the cortical motor area of the brain is now definitely known, and that by the aid of certain measurements we can locate, with sufficient accuracy for operative purposes, the fissure of Rolando, and, in consequence, the ascending parietal, frontal, and other convolutions. The latest authoritative expression of opinion is to the effect that, "there does not yet exist a single accurate observation of a destructive lesion outside the motor area, having produced permanent paralysis, nor does there exist a single accurate observation of a destructive lesion of any extent of the ascending convolutions, which has not given rise to permanent paralysis of the opposite side of the body."[1] Owing to the commissural connections of the various portions of the brain, to the surrounding areas of softening, or to the œdema which accompanies inflammatory lesions, secondary phenomena attendant upon brain-injuries apparently contradict these statements, but primary circumscribed lesions produce symptoms which are neither uncertain nor misleading. For surgical purposes, it must never be lost sight of, that in proportion as the symptoms indicate circumscription of the lesion, so is their value; and that evident implication of many centres, and inconstant symptoms, should make the surgeon review his diagnosis, so that no unnecessary or useless operation may be performed.

There are already on record at least five cases in which success, as regards the discovery of the lesions, has attended an operation guided by cerebral localization, and in three of these cases the patients have recovered or been relieved.

Let no one think that I am contending that cerebral localization can be frequently available for surgical purposes as indicating an operation. This must be comparatively rare, although I believe that confidence resulting from more extended experience will in the future lead to more frequent interference. The chief advantage to be gained at present from our improved knowledge of cerebral topography, is that it will direct in many cases when to withhold operative interference, as has been pointed out under the head of intracranial extravasations of blood.

For surgical purposes, we may consider that the various cerebral centres are located as taught by Lucas-Championnière:—

Lower extremity, summit of the ascending parietal convolution. *Upper and lower extremity*, summit of the ascending frontal and parietal convolutions. *Upper extremity*, middle portion of the ascending frontal convolution. *Upper extremity and aphasia*, inferior third of the ascending frontal, and foot of the third convolution. *Facial paralysis*, inferior third of the ascending frontal, and foot of the second frontal. *Aphasia*, foot of the third frontal. These differ slightly from Ferrier's points, but less so than would appear at first sight, and I am disposed to agree with Lucas-Championnière, that, surgically, they are more practically useful.

Nature and Forms of the Palsies and Convulsions observed in Wounds of the Head.—These palsies result from superficial lesions of those portions of the brain which lie almost without exception beneath the anterior half of the parietal bone (see Fig. 831), and they correspond closely to those experimentally produced upon animals.

As traumatic cerebral lesions are almost never limited to a point, but comprehend a certain extent of brain-tissue, neighboring centres to those chiefly injured will give rise to symptoms confusing the diagnosis. The paralysis is opposite to the side of lesion. The following combinations are those usually met with: Paralysis of face and aphasia. Aphasia and palsy of the arm. Paralysis of the arm and face. Paralysis of the upper and lower extremities. The palsies are more apt to be limited than those of pathological origin. Thus oftentimes the upper extremity is alone affected. Again, incomplete motor paralysis may alone be detected. They often vary in their intensity, according to the greater or less degree of inflammatory complication, or the amount of compression. Spontaneous cures of traumatic paralysis are very rare, although it may improve up to a certain point. More often it increases, and merges its phenomena with those of secondary paralysis. Secondary hemorrhage into inflamed or softened brain-tissue, probably accounts for certain cases of paralysis of intermediary origin. After operation, the paralysis may either suddenly or gradually disappear, but the inflammatory phenomena pass away only gradually. In some rare instances the paralysis disappears or diminishes after operation, only to return at a later period, and to be followed by atrophy. Here the cerebritis has gone on to secondary atrophy instead of to repair. Thus it is clear that irritation and compression of a centre not only suppress its function, but may lead to secondary degeneration, whence the advisability of active interference whenever the functions of a centre are distinctly involved.

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[1] Charcot, Revue de Médecine; Med. Times and Gazette, 1883, vol. i. p. 616, and vol. ii. p. 491; Ibid., 1884, vol. i. p. 270.

Fig. 831.

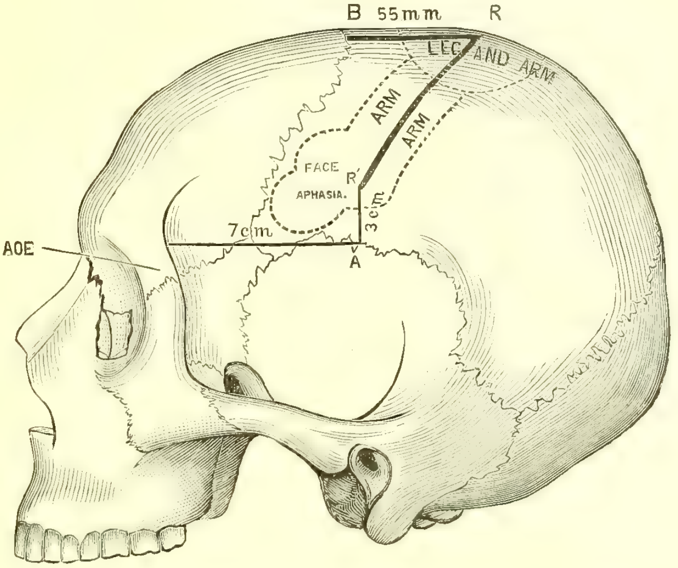

Diagram showing localization of cerebral nerve-centres and determination of line of Rolando. (Modified from Lucas-Championnière.)

Traumatic palsies are usually complete at the outset. They are often preceded, followed by, or alternated with convulsions. The convulsions are not often general at first. They usually commence in one limb. When they become more extended, there is commonly an aggravation of the general condition. Sometimes the paralyzed member is alone affected; at other times it is uninvolved. Generalized convulsions closely resemble those of epilepsy, and are met with in fractures outside of the motor zone. Too little is known of their nature, significance, etc., to warrant any definite statements. As a result of traumatism, true epilepsy, hysteria, or even the convulsions due to apoplexy, may occur. Convulsions are of diagnostic value in direct proportion to their limitation.

Total hemiplegia cannot have a cortical origin, and therefore contra-indicates operation,[1] unless it has been incomplete at the outset, is irregular, and coincides with a very extended depression of the bone covering the motor region of the opposite side. Then a trephine-crown may be applied upon the middle of the line of Rolando, when, if the appearance of the dura mater warrant it, still more bone may be removed.

Monoplegia, or spasms limited to one member, or to a portion of a member, indicates limited lesions. If the lower limb be affected, the upper portion of the ascending parietal convolution, with perhaps also the corresponding part of the ascending frontal, is involved. A trephine-crown must then be applied about the upper part of the Rolandic line.

With paralysis of the arm and leg, the lesion probably involves the upper two-thirds of the ascending convolutions or the paracentral lobule. The trephine should then be placed at the upper part of the line, a little lower than in the preceding case. It may perhaps be necessary to enlarge the opening by cutting out another circle lower down.[2]

Paralysis of the upper extremity alone, probably indicates injury to the middle third of the ascending frontal convolution, and the trephine should be applied a little in front of the middle third of the line of Rolando.

Paralysis of the lower part of the face points to lesion of the inferior third of the ascending convolutions, or of the foot of the second frontal. Here the trephine should be placed a little in front of the inferior third of the Rolandic line.

In all the above instances, one portion of the periphery of the cut should cover the line of Rolando.

Immediate aphasia after injury of the left side of the head, is probably the result of the pressure of a bony fragment or a clot of blood. Should aphasia occur within a few days or weeks, it is probably due to abscess, and although the operation may prove of doubtful value, it may be attempted. The surgeon must never forget, however, that this symptom may result from a lesion extending from the primary injury, seated perhaps at some distance from the speech centre.

In simple aphasia, the trephine-crown should be placed lower down still, in front of and below the inferior extremity of the line (see Fig. 831). Fortunately, in most cases many centres are attacked, and consequently the surface to be exposed is much larger. Thus:—

With paralysis of both lower extremities, the summit of the line, and the contiguous superior portion of the cranium, must be removed; with paralysis of one upper and one lower extremity (hemiplegia), the operation must be performed at the middle and upper portion of the line; in paralysis of the arm with facial palsy, the trephine is to be applied at the inferior third of the line, and a little in front; in palsy of the upper extremity with aphasia, the opening should be made below and in front of the line; with facial paralysis and aphasia, the bone should be removed well in front of the line, and below its inferior extremity (see Fig. 831). The above, following Lucas-Championnière, give all the possible combinations, and the proper positions at which to apply the trephine according to the present state of science. These statements are subject to revision with advancing knowledge. Let the surgeon never forget that it is often necessary to remove large portions of bone to free the injured centres, and to obviate secondary inflammation. Following Gross and Seguin, I shall now proceed to give certain general indications and contra-indications.

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[1] Brain-abscess excepted, when operation is indicated.

[2] MacEwen (Glasgow Medical Journal, Feb. 1884) reports a successful trephining over the middle third of the ascending frontal and parietal convolutions, for hemiplegia the result of syphilitic disease.

Indications.—When hemiplegia occurs after a blow upon the head, or hemiplegia with hemispasm, however slight be the injury—provided that it is in the temporo-parietal region, even although it be not directly over the motor area—the surgeon is justified in exploring that area.

In the coma resulting from intracranial hemorrhage—from the middle meningeal artery for instance, as already pointed out—cerebral localization should guide the surgeon's hand unless in those instances where the effusion is so large as to present no limited compression-symptoms, when the operation should be conducted upon the principles laid down when considering intracranial extravasations of blood.[1] In those cases where the paralysis is on the side of injury, that is, the result of hemorrhage or fracture by counterstroke, provided that laceration of the brain seem improbable, an operation over the motor area of the side opposite to that of injury would seem indicated. This must be a rare condition, and is too often complicated with cerebral laceration at or near the site of the external injury itself.[2]

Contra-indications.—Lesions of the base of the brain, as indicated by paralysis of one or more cranial nerves, neuro-retinitis, or Cheyne-Stokes respiration, I consider, with Gross and Seguin, to be positive contra-indications in otherwise favorable cases.

Hemiplegia accompanied by marked anæsthesia contra-indicates operation, as the latter symptom indicates lesions which implicate other portions of the encephalon than the motor area, and which are too deeply seated to be accessible to operative interference.

How is the line which corresponds to the fissure of Rolando to be mapped out in the living head? There are several methods, the least complex of which I shall now describe.

The head should be shaved, and then placed so that the alveolo-condyloid plane shall be horizontal. With a little care this can be readily done, even with the patient lying down. The next and most important point is to find the bregma. This can oftentimes be felt, but there are two devices which render its detection certain. The most accurate is the "flexible square" of Broca. (Fig. 832.) A little behind the point of junction of the arms is a smooth, conical plug, which is to be introduced into the external auditory meatus. The horizontal branch of the square is then placed beneath the column of the nose (as in Fig. 833), when the posterior border of the vertical arm will indicate the bregma. According to Broca, the bregma is at the front border of this line, but Lucas-Championnière has ascertained that this point is too far forwards. A ready method of finding the bregma, suggested by the latter author, is indicated in Fig. 834. A piece of pasteboard is cut out so as to fit the shaved head, astride of which it is placed, passing across both auditory meatuses. A pencil is passed through it at right angles, at the level of the eyes, so as to ascertain whether the head is in a horizontal position; the middle of the pasteboard, marked B, will then indicate the bregma.

Having determined this all-essential point, measure backwards 5.5 centimetres in man, or 5 centimetres in women (BR), which will give the upper extremity of the Rolandic fissure.[1] Next measure backwards a horizontal line, 7 centimetres in length, from the external angular process of the frontal bone where it begins to curve upwards to form the temporal ridge (Fig. 831).

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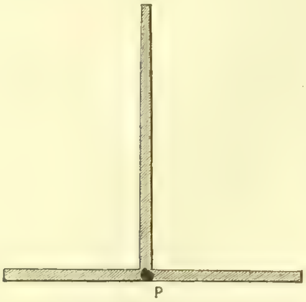
[1] See page 44, *supra*. I must here express my indebtedness to the monograph of M. Lucas-Championnière, and to the summary of the subject by Dr. Seguin in the last edition of Prof. Gross's System of Surgery, vol. ii. p. 41 *et seq.*

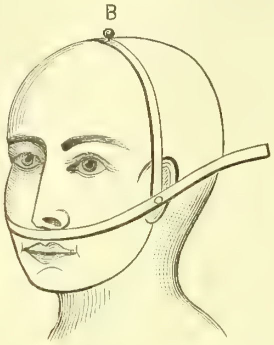
[2] See Prof. S. W. Gross's case, page 46, *supra*.

Fig. 832.



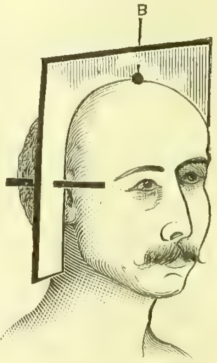
Flexible square of Broca. P. wooden plug to be introduced into auditory meatus. (After Lucas-Championnière.)

Fig. 833.



Flexible square applied. B. bregma. (After Lucas-Championnière.)

Fig. 834.



Ready mode of determining position of bregma. (After Lucas-Championnière.)

Upon this elevate a perpendicular line A R′, 3 centimetres long, which will give the lower point of the fissure of Rolando; connecting these two points by the line R′ R, we have the whole fissure defined with sufficient accuracy. The line should be distinctly marked upon the shaven scalp with an aniline pencil, or with strong tincture of iodine. Even when there is marked œdema, steady pressure with the finger will readily make out the bony point required. As a large-crowned trephine should be used for all operations where we seek to expose individual nerve-centres by the rules of cerebral topography, any little inaccuracy in measurement, which may be unavoidable, proves of no great moment.

In conclusion, I would remark that the whole subject of cerebral localization is yet in its infancy; that what has been said must be considered as provisional; but that by the light already gained, a few surgeons have succeeded in operations, solely guided by cerebral topography, while more have been partially guided, as I have been in two instances; and that in the past operations have been refrained from, and still more will be in the future, which a knowledge of cerebral localization may show to be useless.

Trephining.

It is of the first moment to ascertain the danger inherent to the operation itself. For this purpose it is useless to refer, as is commonly done, to such statistics as those of Fritze, 53.98 per cent.; of Pirogoff, from 60 to 70 per cent.; of Le Fort, 56.22 per cent.; of Otis, 56 per cent.; of Bluhm, 51.25 per cent.; and of Bermann, 46 per cent. of mortality. My reasons for making this sweeping statement are, that, as shown by W. J. Walsham in his admirable paper on the dangers of trephining, investigation proves that in many instances death has been due to injuries other than those of the head, such as rupture of the renal vein, of the liver, etc. In many others, the post-mortem examination has shown that death has resulted, not from the operation, but from the injuries for which the trephining was done. In some cases, which have been quoted at second or third hand, trephining was not performed, but mere elevation of fragments with no removal of sound bone, while in a few no operation at all has been done.

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[1] Broca, Seguin, and most authors say only 5 centimetres, but Lucas-Championnière insists that this is not enough.

To obtain, with anything like an approach to accuracy, the actual death-rate, we must resort to a series of cases where the operation has been performed upon persons in good health, without concomitant cerebral traumatism. The nearest approach to this is where the operation has been done for epilepsy, persistent pain in the head, etc., where the patients have been otherwise in good health. When death results in this class of cases, the operation must certainly be chargeable with it. An examination of the extended statistics of Mr. Walsham, combined with the results of other cases which I have added, show that the immediate mortality only amounts to 10.69 per cent., for out of 159 cases but 17 have proved fatal.[1] That statistics are easily manipulated I am aware; but, as far as I know, these cases have been taken just as they have come. I could add others which might make the exhibit more or less favorable, but the figures quoted are the most extended, and at the same time the most trustworthy, that I am acquainted with. I have added 37 cases of operation for epilepsy and insanity to the 122 of Walsham. Through the kindness of Prof. W. T. Briggs, of Nashville, I am in possession of the details of 33 operations for epilepsy or insanity performed by him, and the details of the remaining 4 cases are also known to me. These figures are therefore more valuable for determining the mortality of the operation, *per se*, than those of Billings's or Eccheverria's tables of operations for epilepsy, in which details are, for the most part, wanting. The latter writer, too, includes cases of recent head injury, to which the term traumatic epilepsy is not strictly applicable. These were doubtless cases of epileptiform convulsion from contusion of the brain, etc., and of course increase the apparent mortality of the operation. For similar reasons, the statement of the mortality of operations for traumatic epilepsy, which will be given hereafter, is not derived from either Billings's or Eccheverria's tables, but from a series of cases with the details of which I am familiar.

A further examination of those cases of which the details are sufficiently accurate, show that in 85 cases where there was no wound or fistulous tract, 72 ended in recovery and 13 in death, a mortality of 15.29 per cent. In 40 additional cases, where a fistula communicated with the dead bone, or an intracranial abscess existed at the time of operation, 39 patients recovered and only one died, a death-rate of 2.5 per cent. In the aggregate of statistics above given, of 159 cases, the mortality of 10.69 per cent. probably fairly represents the risk of the operation *per se*, as it is done for fractures and acute head-injuries, some of which are compound, some of which are made so—as in trephining for simple fracture—and in some of which more or less ancient suppuration exists. I think likewise that the death-rate of 15.29 per cent. may be taken as a guide as to the risks of trephining in simple depressed fracture, that is to say, that it expresses the risk of the operation *per se*, exclusive of that which attends the concomitant intracranial injuries.

The correct appreciation of the share which trephining has in conducing to a fatal result in cases of acute traumatism, such as compound fracture, is in any given case a more difficult matter. The following propositions, which, of course, are only approximately true, may aid in the solution of this difficulty.

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[1] Briggs, Trans. Am. Med. Association, vol. xxxi. 1880, and personal communication from author; Walsham, St. Barth. Hosp. Reports, vol. xviii. p. 220; Byrd, Proceedings of the Am. Surgical Association, 1884.

1. When death occurs from intracranial inflammation, the disease must, if due to the operation, have first started in the bone and dura mater, whence it has spread to the arachnoid, pia mater, and cortical substance of the brain, but very rarely to the white matter.

2. If the intracranial inflammation has its starting point in the brain, both the cortical and medullary portions will probably be involved, and thence the diseased process will extend outwards to the pia mater, arachnoid, etc. In addition, when of traumatic origin, the cerebral substance will probably present either signs of recent contusion or laceration, or traces of such injuries if the case be of some standing.

3. If then, in a given case, laceration or contusion of the brain, and inflammatory involvement of both the medullary and cortical portions of the cerebrum—the inflammation not involving more than the arachnoid membrane—coexist with a healthy condition of the dura mater around the trephine-hole, death certainly has not been hastened by the operation.

4. When intracranial inflammation has existed prior to operation, the operation cannot be justly charged with the fatal result.

5. When the time of onset of intracranial inflammation has been doubtful—that is, when it is uncertain whether it preceded or followed the operation—any opinion as to the effect of the latter upon the result of the case must be purely conjectural. General surgical principles, however, would suggest that inflammation would be more apt to result from contusion of the diploë, with a ragged, shattered state of the bone—which condition necessarily involves defective drainage—than from a clean trephine-cut, with its facilities for ready escape of the wound-fluids.

6. Great caution should be exercised in drawing conclusions in these cases, since the most severe injuries are sometimes recovered from without complications, while the slightest in appearance have at times proved fatal.

From want of knowledge of the actual death-rate of uncomplicated trephining, together with failure to recognize the facts embodied in some of the propositions just stated, and from the unreliable character of the statistics which have been published, as shown by Mr. Walsham, prominent surgeons differ as to the advisability of trephining. Those who are impressed with statistics gathered from any and every source, and unaccompanied by details to show whether operation or concomitant injury has been the cause of death, reprobate the operation; while those who have carefully investigated the matter are gradually reviving the procedure, so that there is reason to hope that it will soon be established on a surer foundation than ever before. I would premise, before giving the results of Mr. Walsham's and my own carefully compiled statistics, that many of the operations included were performed at a time when all operations exhibited a higher rate of mortality than at present. Thus, out of 748 cases there died 276, a percentage of 36.9 per cent.[1] My own experience has taught me that trephining *per se* is not a dangerous operation, and that more patients commonly die from complications which might have been prevented by a timely operation, than from the removal of a disk of healthy bone.

When should the trephine be used? As early as possible, in order to anticipate the secondary inflammatory affections which result from the irritation caused by fragments of bone, and from the impossibility of irritating fluids draining easily away. When is it too late to trephine? Never—since a sufficient number of cases have recovered after trephining for cerebral abscess, than which nothing can be more dangerous; indeed, I myself saved, for the time, one patient who had ceased to breathe for some minutes, and who was only resuscitated by artificial respiration, the use of the battery, etc.[1]

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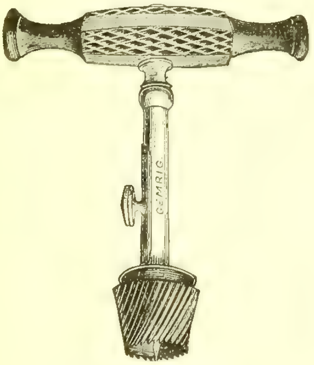
[1] Amidon's statistics and estimate of the dangers of trephining (Med. Record, June 14, 1884), are, I am convinced, too low, the result of omitting unfavorable cases which legitimately should have been included.

The grounds of my belief are found in the following statistics: Of 150 cases of preventive trephining, collected by Walsham, Briggs, and myself, only 33, or 22 per cent., proved fatal, while, on the other hand, 66 deaths, or a mortality of 52.8 per cent. followed 125 operations performed after the supervention of symptoms indicative of brain-disease produced by the skull-injury. I freely admit that the average of cases of preventive trephining may possibly have been less severe than that of the secondary cases, but I think this highly improbable, since, in the severer ones, the patients would hardly have survived until a later date. With the details of the greater number of these cases I am familiar, and they go rather to prove the severity of those in which the operation was preventive. It is in accord with sound surgical principles to expect that preventive trephining should succeed, since by removing sources of irritation we may prevent intracranial mischief which, once initiated, the trephine is usually powerless to relieve, simply because it rarely can do more than remove *one* source of irritation, while others, and the more dangerous, that is, inflammation and its products, cannot be thus favorably influenced in the majority of instances. A cerebral abscess may be successfully evacuated, but much more commonly the operation fails; and the form of intracranial suppuration usually met with is diffused, not circumscribed. Therefore, I repeat, trephine early when possible, but here, as in other cases, use judgment. The indications for trephining for intracranial extravasation of blood, intracranial abscess, and depressed fracture, will all be found under their appropriate headings.

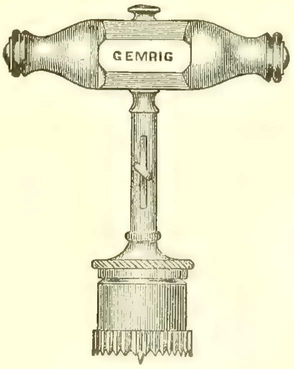
Method of Performing the Operation.—I shall include, under the term trephining, all operations which involve removal of more or less sound bone, whether by the trephine, bone-forceps, or Hey's saw.[2] The special instruments required are an elevator,[3] a knife with raspatory attached,[4] trephines of various sizes (Figs. 835, 836), a pair of stout forceps, a trephine-brush (Fig. 837), a

Fig. 835.



Conical trephine.

Fig. 836.



Ordinary trephine.

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[1] He died six and a half days subsequently from exhaustion, the result of his second attack of erysipelas within three weeks. (See page 84, *supra.*)

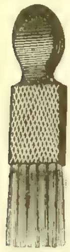
[2] Scultetus's saw, in reality.

[3] See Vol. IV. p. 452, Fig. 689.

[4] See Vol. IV. p. 450, Fig. 678.

pair of Hey's saws (Figs. 838, 839), and gouge-forceps[1] (the *rongeur*, as it is sometimes called), or a pair of small, cutting bone-forceps.[2] Some surgeons prefer to use the lenticular (Fig. 840), to elevate the bone and smooth the edges of the trephine-cut; but I have never seen any necessity for its use, as an elevator in careful hands is perfectly safe, and its rough, serrated edges serve admirably to file away, as it were, any inequalities left by fragments of the brittle inner table, which may have been left at the periphery of the aperture. The *rongeur* is an admirable instrument, and, where it can be used, serves a better purpose than the trephine or Hey's saw, in removing an overhanging shelf of bone, while it is a more rapid and safer instrument. Of the two forms of trephine, the conical, commonly called Galt's, is the safer, since from its form it is almost impossible for it to injure the brain, if, as the last portions of the inner table are divided, undue pressure should be made; while under these circumstances the old form of instrument has occasionally been accidentally plunged into the brain-substance. There is a theoretical objection to the conical instrument—viz., that from the uneven division of the outer and inner portions of the skull, necrosis is more apt to occur—but I am unaware of any facts to support the assertion that such is the case. The instruments should be placed in a solution of carbolic acid, one part to twenty of water, and the scalp cleansed by a solution of turpentine two parts, alcohol fourteen parts. The sponges should be kept in corrosive sublimate, one part to two thousand, with which solution the wound also should be kept more or less constantly irrigated.

Fig. 837.



Trephine-brush.

Fig. 838.

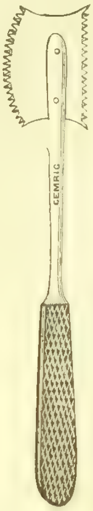
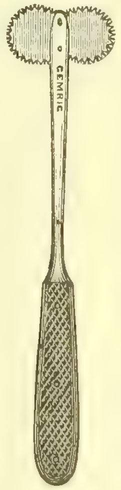
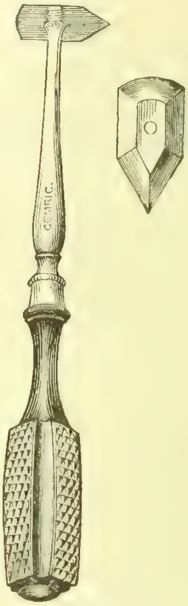


Fig. 839.



Two forms of Hey's saw.

Fig. 840.



Lenticular.

In most cases of compound fracture, flaps formed by incisions, regulated somewhat by the original wound, will readily expose the bone; indeed, in

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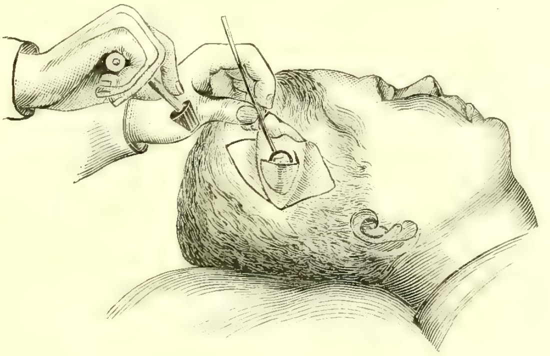
[1] See Vol. IV. p. 452, Fig. 686.

[2] A few American surgeons are enthusiastic in their advocacy of the dental engine instead of the trephine in removing portions of the skull. Having had no personal acquaintance with this method of operating, I can neither commend nor condemn it.

some cases none are needed. Where there is no wound, crucial, V-shaped, or, which I greatly prefer, a horseshoe-shaped incision, should be made. Any bleeding which does not spontaneously cease in a few moments, should be arrested with serre-fines, or by the application of a piece of dry antiseptic lint, which will, by the pressure of an assistant's fingers, stanch the blood. Ligatures may be used if preferred, but are usually unnecessary. The periosteum should next be incised, carefully separated by the raspatory or knife-handle, and kept out of harm's way, so as to avoid, as much as possible, the risk of future necrosis. The trephine, with its centre-pin protruded about one-sixteenth of an inch, and firmly screwed in this position, should be now applied to the portion of bone which it is intended to remove. The instrument should be worked with a light, sharp, quick movement from left to right, and from right to left, care being taken not to press unevenly, and the pressure being chiefly exerted as the hand is carried from left to right. As soon as a sufficient groove has been cut to steady the trephine, the centre-pin should be withdrawn, and fixed so as to avoid injury to the dura mater. When the outer table of the skull is cut through, the bone-dust, which up to this time has been dry, becomes soft and bloody, as the instrument penetrates into the diploë. Both the sound and feel are also different. Where the use of the centre-pin is undesirable, Dr. P. H. Watson, of Edinburgh, has suggested that the instrument should be steadied by applying it through a perforated piece of pasteboard, firmly held against the bone. The trephine should be removed from time to time, and cleansed in the carbolized water, either by the brush or a sponge. The detritus lying in the bony groove should be removed by a tooth-pick or the flat end of a probe, advantage being taken at the same time to measure the depth of the cut at various portions of the circumference, to ascertain whether the bone is being evenly divided. If one segment of the groove be deeper than another, the trephine must be inclined towards the shallow side, and pressure made at that point alone until the groove is of equal depth throughout. The surgeon must remember that the bone is frequently of unequal thickness at various parts of the circumference of a trephine-cut, so that while the osseous disk may be firmly held fast at some point by portions of the inner table, the teeth of the instrument may at other points be tearing the dura mater, the chief thing to be avoided. When the instrument reaches the inner table, both the sound to the ear and the sensation conveyed to the hand usually give warning. Great care

Fig. 841.



Application of the trephine.

should now be exercised, and each turn must be made cautiously and with very light pressure. By a slight rocking movement of the trephine, the looseness of the piece can be ascertained; but it is better to lay the instrument aside, and seizing the edge of the disk in the grasp of a pair of stout forceps, gently move it from side to side. If loosened at one edge, the trephine teeth must be made to cut upon the opposite, attached part, for a turn or two, when the forceps should again test the stability of the disk. When loosened, the bone may come away in the crown of the trephine, but I think it safer to remove it by tilting the piece out with the forceps, using a rocking movement, and always drawing it out towards that side where any portion of the inner table remains unsawn, as then the dura mater escapes the slightest injury from the other thoroughly sawn and perhaps splintered edge of bone. Any portions of the inner table that are left behind, can be removed with the forceps, elevator, or lenticular.

If the case be one of punctured fracture, a trephine large enough to include the starring of the outer table should be used, when most of the fragments will come away at once. Great care must be exercised in removing splinters of the inner table, lest the dura mater or venous sinuses be wounded. In the case of an ordinary depressed fracture, the trephine should be applied so that only about two-thirds of the circumference of the cut will be located upon the sound bone. A trephine of only sufficient size to enable an easy introduction of the elevator should be used. If after the removal of a disk of bone sufficient room have not been obtained, free use of the gouge-forceps or Hey's saw will usually suffice to enlarge the opening; otherwise, a new segment of bone must be removed with the trephine. If the fracture is near a sinus which we suspect may have been wounded by the depressed fragments, the trephine-cut should be so planned as to give free access, if necessary, to any bleeding point. When operating for blood or pus within the cranium, a trephine with a large crown is preferable. Abernethy suggested, that at the very outset of suppurative osteomyelitis a disk of the outer table only of the skull should be removed with the trephine, so as to give free vent to the unhealthy pus. The advice is theoretically good, and has been approved by Lidell, but I am not aware that it has ever been put in practice.

Performed for whatever purpose, all loose fragments of bone should be removed, depressed pieces elevated, but allowed to remain *in situ*, unless evidently so much denuded of pericranium and dura mater as to be likely to become necrosed, and the edges of the opening in the skull smoothed as far as practicable, with the gouge-forceps, or file-surface of the elevator, so as to lessen the risk of ulceration of the dura mater. If the sinus-like veins of the diploë bleed, a pellet of softened wax will readily arrest the flow, if the point be accessible. I was once compelled, on account of the very free hemorrhage, to pass a pledget of lint beneath the margins of an irregular opening of the frontal bone, when the inner table and diploë were broken for a considerable distance beyond the outer table, and to leave it there between the dura mater and bone for twenty-four hours. The bleeding in this case was so free that I had not time to remove the bony edge to reach the source of hemorrhage, which burst out as soon as I had elevated a large fragment. The patient recovered.

In another instance, where I successfully removed nearly the whole of the left temporal fossa, for a terrible crush of this part, after taking up and tying with fine catgut one or more branches of the middle meningeal artery, which lay in the dura mater, I was finally compelled to fill the whole wound with corrosive-sublimate cotton, and lay down the flaps to arrest the free oozing; this case also ended in recovery.

After arresting hemorrhage, the wound should be freely and repeatedly washed out with the mercuric-bichloride solution, and the flaps laid in place and kept in position by straps or sutures. Means for free drainage must be provided, either by the arrangement of the flaps or by a small drainage tube. Over all, several layers of mercuric or carbolic gauze, or layers of lint soaked in the mercuric or carbolic solution should be placed and retained by the gentle pressure of a well-applied bandage. The dressings should be frequently changed, lest pent-up pus beneath the flaps should prove a cause of cerebral oppression. The after-treatment should be strictly antiseptic as far as the wound is concerned, and should be that of a bad cranial fracture as regards the head symptoms. Eccheverria recommends the administration of conium and ergot after trephining for epilepsy, with the constant application of the ice-cap to the head for a number of days, after which frequent cold affusions may be substituted. A head-cap, formed of a continuous coil of block-tin pipe, through which iced water is kept constantly flowing, is the most satisfactory way of applying dry cold.[1]

It is unadvisable to apply the trephine over the course of sutures, if it can be avoided, simply because the dura mater usually adheres at these points with exceptional tenacity, rendering tearing of that membrane a probable accident, and, also, because of the great difference in the thickness of the bone; thus, along the sagittal suture, which is grooved for the longitudinal sinus, at one portion of the periphery of the trephine-cut the teeth would almost certainly touch the dura mater, while at other portions the bone would be only half sawn through. In cases where it seems imperative to apply the trephine over a suture, especially one beneath which lies a sinus, there is, fortunately, very frequently a separation of the dura mater produced by the injury, which removes it out of harm's way. Notwithstanding, when possible, sutures should be avoided. In like manner, trephining over the anterior inferior parietal angle is undesirable, lest the middle meningeal artery should be wounded. If this happen, plugging the bony canal with a sharpened match, or a pellet of wax, will usually arrest the bleeding. If not, a knitting-needle or iron wire at a dull red heat may be made to effectually seal the vessel. The course of the lateral sinus, which, in a general way, may be said to correspond to a line drawn from the external occipital protuberance to the external auditory meatus, should also be avoided.

Trephining over the frontal sinus, it is said, must never be done except under compulsion, lest an aërial fistula result. This presupposes that the cavity is always present and in the same position. Mr. Hilton[2] has shown that the sinus does not begin to make its appearance before fifteen or sixteen years of age, and that in many cases it may not begin to be developed until a still later period. Examining different adult crania, he found these cavities sometimes altogether absent. Oftentimes but one small cell was found on *one* side of the median line, while in other cases there was a small cell on either side. In other specimens there were fair sized cavities, at times symmetrical, but usually differing much in outline and dimensions. Sometimes the sinus may extend upwards nearly the whole distance of the forehead, and backwards an inch or more along the orbital plates of the frontal bone. An aërial fistula does not always result;[3] still, when possible, the supposed site of the frontal sinuses should be avoided. When it is not possible, a large-crowned instrument must be used to perforate the outer wall of the sinus, and a smaller one for the inner.

Finally, when there are imperative reasons for so doing, the surgeon may trephine at any point of the skull, bearing in mind the special dangers to be avoided in certain localities, and remembering that there is no such thing as an invariable rule in surgery. Sometimes Hey's saw or the gouge-forceps can be with advantage substituted for the trephine. With these instruments, a projecting angle of bone may be removed, or a strip of bone sawn from an overhanging edge, so as to permit the introduction of the elevator and the restoration of depressed fragments to their normal level, or to allow their successful removal.

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[1] See, also, Petitgand's apparatus, Vol. II. p. 173, Fig. 272.

[2] Guy's Hosp. Reports, 2d series, vol. viii. pp. 362 *et seq.*

[3] See Larrey, op. cit.

The skullcap varies in thickness from one-fifth of an inch, upon the average, to as much as three-fourths of an inch at the occipital protuberance. In the young child, the diploë may be absent, whence great caution must be exercised in those rare cases in which the operation is required in the very young.[1] In the old, the bone is often much thinned by absorption. The advice of Holden is admirable: "Think that you are operating on the thinnest skull ever seen, and thinner in one portion of the circle than the other." The trephine-hole is usually closed by fibrous tissue, sometimes by fibro-cartilage, and, very rarely, by a more or less complete, thin plate of bone. Sometimes the bony margins thicken, forming a raised ring, while at other times they become thinner, and blend with an imperfect ring of osseous tissue which extends into the fibrous membrane, thus closing the opening to a varying extent.

As an exceedingly rare secondary complication of trephining, I would mention hemorrhage from the middle meningeal artery. Thus, Mr. Jackson reports a secondary and uncontrollable bleeding from this vessel, which required, six weeks after trephining, ligature of the carotid artery. The patient recovered.[2]

TREPHINING IN EPILEPSY.—Each case of this disease must be judged by itself. All that I shall attempt, therefore, will be to give the mortality and probability of success attendant upon operative interference, with the indications which have induced surgeons to trephine, in this condition.

Causes: Lesions found in the Bone and Dura Mater.—The cause of the lesions inducing epilepsy has been in the majority of instances the application of great violence to the skull, but many times the reverse has been noted. When the result of great violence, the disease has usually been due to depressed bone-fragments. When the exciting cause has been a slight injury, the lesions usually observed have been chronic inflammation and thickening of the bone, leading perhaps to the formation of an exostosis. Finally, merely inflammation and thickening of the dura mater or pericranium have been the sole lesions detected in a number of cases. Sometimes the convulsions have been the result of a slight injury which has detached a small fragment of the inner table. "Where mania, idiocy, or other form of mental deterioration occurred, the lesion may be said generally, to have existed in the anterior half-segment of the cranium; where paralysis was present, the parietal, with exception of two cases, was the part injured, the lesion, however, in both of these exceptional cases being so far back as to be practically in the parietal region."[3]

The onset of the disease has been, in a few cases, immediately after the injury, but in the majority a variable period has elapsed, in a few cases as much even as thirteen years. In proportion to the duration of the disease is usually the impairment of the intellect, from which the important precept may be drawn, to trephine early, since, although some of the cases of longest duration and of gravest character have been entirely relieved by operation, most patients, according to Walsham's statistics, are only improved, are unrelieved, or die.

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[1] A child, twelve months old, has been successfully trephined for a punctured fracture of the skull, produced by a large nail. (Gross, op. cit., vol. ii. p. 88.)

[2] Brit. Med. Journal, November 1, 1876.

[3] Walsham, St. Bartholomew's Hospital Reports, vol. xix. p. 139.

Symptoms Indicating Operation.—Pain in the head, mostly located at or about the injured spot, has been present in most instances. Out of a total of 82 cases collected by Mr. Walsham, in 3 there were no local indications, while in 44 a depressed cicatrix or a depressed spot, painful or tender on pressure, existed. In some, the cicatrix or depressed spot was merely sensitive, in others the seat of constant pain.

Pressure at these points produced in 2 cases vertigo, in 1 convulsions, and in 1 rigidity; in 1—a point worthy of future investigation—the temperature was 3° F. higher at the tender spot than elsewhere upon the cranium. In 8 cases there was neither cicatrix nor depression, but a tender, painful, or sensitive spot, pressure upon which caused pain, vertigo, or convulsions. In 8 cases there was a fistulous tract leading down to dead bone. In 3 patients a fissure was felt in the bone. In 2 there was a bony elevation. In 2 there was a tumor or swelling of the bone. Eleven operations were said to have been performed at the site of a former wound or injury. In one instance there was no scar or any other local indication, but from the symptoms trephining seemed indicated over the fissure of Rolando, and was there successfully applied.[1]

In the majority of cases, depressed bone was discovered at the operation, or the osseous tissue was found variously altered and diseased. Where carious or necrosed, a sinus generally led down to the bone. The dura mater was usually found healthy, but in other cases was thickened, congested, vascular, or adherent. A strange fact is, that in 16 cases nothing to account for the epilepsy could be detected, and yet in 10 such cases, in which recovery took place, 7 patients were cured, 2 were relieved, and only 1 was unrelieved. In one of the cases in which the patient died unrelieved, an undetected bone-fragment was found after death to have caused the failure of the operation.

Results ; Prognosis.—In 48 of the 82 cases under review a cure was effected, the patients being restored to good health ; 13 patients were relieved, some of whom may ultimately have been really cured, as they were steadily improving when last heard from.[2] In a certain proportion the fits persisted at first, and gradually disappeared. Four patients were not improved, and 17 died. In certain of these deaths the fatal termination occurred so long afterwards as hardly to be fairly attributable to the operation.

Taking the whole number of cases collected by Walsham, and 37 added by myself, making in all 167, 32 ended fatally, a mortality of 19.16 per cent. As to the prognosis, with regard to recovery from the epilepsy, etc., the cases above referred to, where the details are given, furnish the only thoroughly trustworthy data which are available.

If there is a distinct history of injury, a well-marked cicatrix, or a sinus leading down to dead bone, and if the epilepsy has undoubtedly been initiated by the injury, there can be no doubt of the propriety of operating after the failure of medical treatment. So simple an operation as mere removal of the cicatrix and pericranium, will in certain cases permanently relieve epilepsy, as in a patient of Dr. J. Ewing Mears, of Philadelphia. Portal cured one case of epilepsy by excising a cicatrix upon the thumb, and another by a similar operation upon a scar of the scalp. The amputation of injured toes, lithotomy, and evacuating the contents of a wounded eye have also cured epileptics. In most of these cases a so-called aura has been present, starting in the point operated upon. Wherever similar expedients seem indicated they should therefore be tried, if depressed bone be not manifestly the exciting cause. With Mr. Walsham, I would add, as to doubtful cases where the indications are not clear, that with the fact before us that, in many cases where the history of an injury has been obscure, or where no history whatever has been obtained, or where the only local indication has been a sensitive, painful, or even a tender spot without any evidence of depression or inequality of bone, patients have been rescued from a miserable existence and restored to one of health and comfort, "I think we may go further, and say that even with such slight indications the trephine ought to be used; and holding as I do that the operation is one in itself not attended, when the membranes are not wounded, with much danger, I would give the patient the benefit of the doubt, and would myself press the operation."[1] What if at the operation nothing be found? Wait for some months, and then, if no improvement take place, the operation may be repeated near the site of the first, remembering that in one case mentioned, an undetected fragment of the inner table was found, after death, to be the cause of the disease. As to the operation itself, Prof. Briggs, whose experience is greater than that of any other operator in this country, points out that, to be successful, all the thickened and diseased bone should be removed. In one of his cases he successfully cut out six large buttons of bone with the intervening osseous tissue. Prof. Briggs also calls attention to the very important fact that after removal of the bone, we should still watch the case, lest some other source of peripheral irritation should arise, such as a painful cicatrix, which would then require excision. One of the sources of failure in operations for epilepsy, is the neglect of after-treatment, medical as well as surgical. The operation indeed removes the most important cause of the epilepsy, but only one cause. The disturbed circulation in the nervous centres, and the excessive mobility of the nervous system, can only disappear with time; and if all other sources of peripheral irritation are not most carefully guarded against, the patient may be slightly if at all benefited, whereas judicious after-treatment will sometimes relieve an apparent operative failure.

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[1] Walsham, loc. cit., p. 133.

[2] One of the cured patients in this list was reported at first as only unimproved, yet a later report showed that he had had no fits for years.

Injuries of the Cranial Nerves.

As a consequence of head injury, one or more of the cranial nerves may have its functions suppressed, either temporarily or permanently. This may result from various causes: (1) the nerve may be divided by the vulnerating body, as in thrust-wounds of the orbit or nose, or in penetrating bullet-wounds of the head; (2) by laceration of the brain-tissue, the nerve may be torn from its centre; (3) it may be torn across by the fissure of a basal fracture, traversing the foramen through which it passes out of the cranium, or the bony canal in which it lies; (4) it may be compressed by displaced fragments of bone; (5) it may be compressed by blood, either effused into its sheath, or along its course through the skull; (6) the deep origin of the nerve may be destroyed or compressed by effusion, either hemorrhagic or inflammatory.

The olfactory, optic, and orbital nerves, are those most frequently lacerated by thrust-wounds, etc. Injuries from such a cause are rare. Owing to the frequency with which the petrous portion of the temporal bone is involved in fractures, injuries of the facial and auditory nerves are of common occurrence. Palsies of these nerves in undoubted fractures of the petrous bone do not always appear at first, nor are they persistent, which shows that they are by no means certain signs of a basal fracture. When loss of function is produced by hemorrhagic pressure, or by that of inflammatory products, gradual recovery not uncommonly ensues. I shall now briefly allude to the injuries of each special nerve, and the consequent lesions—if any—produced in distant organs.

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[1] Walsham, loc. cit., p. 143.

First Pair, or Olfactory Nerves.—A fracture involving the cribriform plate of the ethmoid must almost of necessity injure the olfactory nerves. Owing to the excessive softness and delicacy of these nerves, and to their being firmly held against the under surface of the anterior cerebral lobes by the arachnoid, injuries which tend to drive the anterior portions of the brain against the bony floor of the anterior cranial fossæ, may readily injure the olfactory bulbs. According to Dr. Ogle, blows upon the occiput—as in two cases reported by him—may rupture the nerve-filaments as they pass from the bulb through the foramina in the cribriform plate of the ethmoid bone. Hemorrhage into the neighboring portions of the anterior lobes, or surrounding and compressing the nerve between the bone and brain—to judge from results—is a much more common cause of loss of smell than basal fracture. I have seen one case of anosmia, in private practice, the result of a probable fracture of the base of the skull. Four years after the accident, when I first saw this gentleman, all sense of smell was absolutely lost, and this had been so since the date of the injury. Brodie reports two cases of anosmia after head-injury. In one, there commenced some time after the injury a gradual restoration of the sense of smell, which steadily went on until a perfect cure resulted; in the other, examined many years after, complete loss of smell persisted. In an excellent paper, Mr. Henry Lee[1] relates a case showing how caution must be exercised in determining the presence or absence of anosmia. A patient in St. George's Hospital appeared for several weeks to have lost the sense of smell upon the left side, after a traumatism of the head which had resulted in facial paralysis. Finally, a more careful examination showed that, owing to the combined effect of a deviated nasal septum and paralysis of the dilator naris, etc., the left nostril had practically become impervious to air; when, however, the left nostril was held open, the man perceived odors with equal facility upon each side of the nose. Anosmia is sometimes said to coexist with loss of taste, but this is a mistake. True *sapors* —that is, excitors of the sense of taste, such as salt, acids, or bitters, which are non-volatile—can be readily tasted after complete destruction of the first pair of nerves. Those substances which depend chiefly upon volatile *odors* for their so-called taste—and to odor most articles of food owe their palatableness—can no longer be distinguished from tasteless or even disagreeable substances. This was the case with the patient that was under my care. From the propinquity of the centres of speech and smell, anosmia and aphasia not uncommonly coexist.

Second Pair, or Optic Nerves.—The optic nerve may be torn through by a fracture traversing the orbit; may be compressed by hemorrhage within the neurilemma; may be crushed by a displaced fragment of bone; or may be divided by a penetrating wound. Of the first method of causation, a case reported by M. Pigné is a good illustration. Here, from the application of a powerful compressing force, that is, the passage of a carriage-wheel over the head, the orbital roof was extensively comminuted, resulting in a complete tearing across of the optic nerve and of all the recti muscles.[2] As an instance of a displaced fragment of bone suppressing the function of the optic nerves,

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[1] Medical Times and Gazette, new series, vol. iv. p. 238 *et seq.* 1852.

[2] Bull. de la Soc. Anat. de Paris, p. 228. 1837.

Brodie relates the case of an old man, run over by a cart, who with a depressed fracture of one parietal bone complained of total blindness. After death, fragments of the sphenoid bone were found compressing both optic nerves, just behind the orbits.[1]

Hewett says that there are, in St. George's Hospital Museum, two optic nerves derived from the same patient, where the neurilemma was distended with blood, thus producing compression. He says that he has found this condition in several instances after severe injuries of the head, and especially after those near the orbits. The nerve-sheath was in these cases distended with blood, which had escaped from the veins contained within the neurilemma. This observation of Sir P. Hewett serves to explain the gradual recovery of sight which takes place after certain head-injuries, where primarily vision has been lost.[2] M. Duponchel reports a case where the optic nerve was divided by a penetrating wound of the orbit:—

> A dragoon was wounded in a duel by a sabre-thrust. After death it was found that the weapon had passed beneath the globe of the eye, and had completely divided the optic nerve.[3]

THIRD PAIR; OCULO-MOTOR NERVES.— Although from their relations, this pair of nerves is less liable to be torn by osseous fragments than those just mentioned, it is quite often compressed by extravasated blood. While all the parts supplied by this nerve may be paralyzed, it is much more frequent for the levator palpebræ to be alone affected, resulting in complete ptosis. Still more strange is it to learn, that one branch of the upper division of the nerve, with another branch of its lower division, may be alone affected. In a case which I have already related to illustrate another point, the third nerve upon the left side was compressed by an enormous clot of blood proceeding from a ruptured middle meningeal artery, and during life the left pupil was widely dilated.[4] Brodie[5] relates an interesting case in which recovery ensued, and as, though the paretic condition of the pupil persisted so long, complete restoration eventually took place, it may not be amiss to give here an abstract.

> A gentleman received a severe contusion of the head by a fall from his horse, which rendered him insensible; and the fact that the loss of consciousness persisted for several days, showed that the cause was some form of compression. When consciousness began to return, ptosis of the right upper eyelid was observed, with a completely dilated pupil, which did not contract with the stimulus of light. It was only after the lapse of nearly a year that the right pupil returned to its normal condition.

Those cases where vision is said to have been affected in injuries of the third nerve, are probably not due to any accompanying lesion of the optic nerve, but to the state of the pupil. If such be the case, a stenopaic slit, or pinhole through a card, will render a differential diagnosis easy, provided that no original difference from refractive anomaly existed in the eyes previous to the accident. An ophthalmoscopic examination would, in these latter circumstances, be necessary to determine whether the impairment of vision, after the use of a stenopaic apparatus, was due to injury, or to congenital or acquired defect of refraction.

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[1] Med.-Chir. Trans., vol. xiv. p. 348.

[2] Gaz. des Hôpit., p. 446. 1854.

[3] Bull. de la Soc. d'Émulation, 1822; quoted by Aran.

[4] See, also, Aran, Archives Gén. de Méd., 4e série, tome vi. p. 338; Pick (Left third nerve compressed in sella turcica by blood clot), Brit. Med. Journ., May 27, 1865.

[5] Brodie, loc. cit., p. 354.

FOURTH PAIR; PATHETIC NERVES.—Owing to the protected position enjoyed by these nerves, they seem never to be injured; at least I have not been able to find a record of any such accident.

FIFTH PAIR; TRIFACIAL NERVES.—These nerves not uncommonly suffer in head-injuries, and usually in conjunction with lesions of some other cranial nerve.[1] All the branches of the nerve are rarely involved, but more than one are usually affected.

A man was rendered completely insensible by a severe blow upon the left side of the head, inflicted by a heavy piece of timber. Much blood was lost from the ears, nose, and mouth. Regaining consciousness upon the following day, right hemiplegia and ptosis of the left eyelid were noted. Seven weeks afterwards, upon admission to St. George's Hospital, he complained of severe pain upon the left side of the head; the ptosis persisted, and there was a purulent discharge from the left ear. The hemiplegia had almost entirely disappeared. There was total loss of sensibility in all parts supplied by the left fifth nerve; he could neither taste nor feel upon the left side of the tongue, except at its root; a probe was not felt in the nostril of that side; and cutaneous sensibility was absent over the whole left side of the face, upper part of the head, etc. Gradual improvement ensued, but the cornea became opaque, owing, perhaps, to the eye remaining partly open and without sensation, thus allowing foreign bodies to lodge within the lids and there remain a constant source of irritation. He could close the eye when directed to do so.[2]

Another interesting case is on record, where, after a severe injury, both sensation and motion of the right side of the face were seriously impaired. In about two weeks, the conjunctiva of the right eye became chemosed; the cornea had lost all sensibility; it was cloudy, and presented, at its lower part, appearances of an interlamellar abscess. Soon slight ulceration commenced over the site of the abscess, extending until, between two and three months after the injury, the cornea gave way with a loss of only the aqueous humor. The cornea finally cicatrized, and the patient could see through its upper segment. Ultimately, both sensation and motion of the right side of the face were restored.[3]

Where recovery ensues, the paralysis has probably been due to hemorrhagic or inflammatory deposit; where the loss of function is permanent, tearing of the nerve, or permanent pressure by displaced bone, is probably the cause. Why in some cases corneal ulceration takes place, while in others it does not, is a much vexed question which it is beside our present purpose to attempt to elucidate.[4]

SIXTH PAIR; ABDUCENT NERVES.—This nerve being small, and lodged in a groove upon the upper portion of the petrous part of the temporal bone, is liable to be torn across in fractures implicating this part of the base of the skull.

Paralysis of this nerve is apt to coexist with a similar condition of some of the other cerebral nerves. Recovery has ensued in several such cases, where not only the abducent nerve has been affected, but where other cerebral nerves were at the same time paralyzed.

Aran reported a case where, after a violent blow upon the head, the right abducent nerve was completely paralyzed. He considered that the lesion was produced by a fracture of the cranial base.[1] Still more striking as an illustration is the following:—

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[1] Thus Hulke (Lancet, Nov. 30, 1878, p. 769) reports a case in which, after death, the right portio dura and the fifth and second nerves were found to have been torn.

[2] Lee, Med. Times and Gazette, new series, vol. iv. p. 240. 1852.

[3] Richard, Gaz. des Hôpitaux, 1844. I quote this case on the authority of Hewett (op. cit., vol. i. p. 616), having failed to gain access to the original report.

[4] See Dixon, Med.-Chirurg. Trans., vol. xxviii. p. 373 *et seq.*

A man, aged forty years, fell from a height of twelve metres upon his feet. He experienced only some slight symptoms of concussion. Omitting unnecessary details, among his other symptoms he had internal squint of the right eye. Dying about four months subsequently, an extensive fracture was found, implicating the clinoid processes and the right petrous bone, a considerable fragment of which was entirely detached from the rest of the skull. The sixth nerve was torn by the edge of the broken bone.[2]

SEVENTH PAIR; FACIAL AND AUDITORY NERVES.—(1) *Portio Dura or Facial Nerve.*—The long, bony canal in which the greater part of the intracranial segment of the facial nerve is lodged, occupying as it does the petrous portion of the temporal bone, renders its tearing or compression an almost necessary consequence of fractures of the middle fossæ of the skull. Indeed, paralysis of this nerve has been from time out of mind considered to be a valuable sign of fracture of the base of the skull. Loss of function of this nerve is, however, not conclusive proof that a fissure has traversed its bony canal, for it may be due, as in a case observed by Hewett, to the pressure of a small clot of blood in the common sheath between the facial and auditory nerves. Again, in undoubted fracture this nerve may not be affected at first, showing that its paralysis in basal fracture may be due to mere irritation by the broken fragments and subsequent inflammatory pressure, rather than to tearing, thus explaining—remembering that absorbable blood-clot may also compress the facial nerve—the gradual recovery of function that may ensue after the most strongly-marked paralysis. Pick reports that of ten cases of facial paralysis after basal fracture, in only two was it present at the time of the patient's admission into the hospital, while in the remaining eight cases the nerve-affection appeared from the second to the sixth day.[3]

(2) *Portio Mollis or Auditory Nerve.*—For similar anatomical reasons to those given for the facial, the auditory nerve is not uncommonly injured in fractures of the cranial base. Recovery from such injuries being rare, it is not often that deafness from fractured skull is observed.

The following case, reported by Aran,[4] illustrates how the portio mollis may be torn while the portio dura of the seventh pair remains intact, although included in the same bony canal for a part of its course. The reverse is also equally true, but is explicable by the longer and more tortuous course pursued by the facial nerve through the temporal bone.

A young man fell from a height of twenty feet, and lost consciousness. On the fifth day, a fracture of the temporal bone was diagnosed from symptoms which I need not detail. Death took place on the sixth day, and at the autopsy, among other injuries, a fissure was found traversing the petrous bone so as to tear the auditory nerve.

EIGHTH AND NINTH PAIRS; GLOSSO-PHARYNGEAL, PNEUMOGASTRIC, SPINAL ACCESSORY, AND HYPOGLOSSAL NERVES.—Intracranial injuries of these nerves are of rare occurrence, owing to their passage through short, bony foramina, the first three in conjunction with the large, soft, compressible jugular vein. These are also protected in their intracranial course by one of the largest of the subarachnoidean spaces, which is filled with a fluid that readily becomes displaced when blood is extravasated. After persisting for a time, symptoms due to traumatic affections of these nerves may disappear. Owing to the emergence of the three first mentioned nerves through the same foramen, their affections must be considered more or less together.

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[1] Arch. Gén de Méd., 4e sér., tome vi. p. 338.

[2] Ibid., p. 191.

[3] British Med. Journ., vol. i. p. 530. 1865.

[4] Aran, loc. cit.

Mr. Hilton, in his lectures upon fractures of the cranium, relates one case where, with lesions of other cerebral nerves, the result of a severe injury to the head, the patient exhibited great difficulty of deglutition; the "tongue was thrust over to the other side; articulation was slow, and enunciation very imperfect." Pain in the neck, upon the affected side, extending as far as the clavicle, was complained of. Recovery, leaving only slight traces of paralysis, took place after the lapse of a few months.

Aphonia, dysphagia, dyspnœa, with contraction of the muscles accessory to respiration, and more or less paralysis of the pharynx, œsophagus, and stomach, were the main symptoms presented by a patient who recovered from a brain-wound, in which the glosso-pharyngeal, pneumogastric, hypoglossal, spinal accessory and suboccipital nerves were divided by the thrust of a lance.

Finally, I shall give an abstract of the voluminous notes of Mr. Hilton on a case of basal fracture in which the fragments became secondarily displaced, causing compression of the eighth pair of nerves.

A man with basal fracture of the skull was admitted into Guy's Hospital, and did well until the tenth day, when, after getting out of bed and walking across the ward, he had rigors, followed by vomiting, and gradually lapsed into semicoma. Later in the day, dysphagia, with a gasping respiration, was noticed. The difficulty of deglutition rapidly increased, until before morning "everything was rejected as soon as it reached the pharynx." Death resulted within forty-eight hours from coma and asphyxia. Post-mortem examination revealed a healthy state of the brain and its membranes; there were signs neither of inflammation nor of injury of the brain-tissue. The line of fracture passed through the right jugular foramen, whence it ran across the base of the skull, dividing the posterior part of the cranium into two portions, which freely moved upon one another. The fragments were displaced in such a manner that the right cerebellar fossa was lower than the left.[1]

Doubtless some motion made by this patient in walking across the ward caused the bony displacement which resulted in his death. This resulted from asphyxia, as was the case in a patient of Agnew's. In Hilton's case it is a matter for regret that no examination of the lungs was made, to determine whether there were actually pulmonary lesions as in Dr. Agnew's patient, and as in one of Verneuil's.[2]

In Agnew's case, irregular, labored, noisy respiration, with great dulness upon percussion over the back of the chest, was noticed during life, and after death a blood-extravasation into the medulla oblongata, that is, into the pneumogastric centre, was discovered, with intense engorgement of both lungs.[3]

Erichsen says that he has seen "repeated vomitings with palpitations, and a sense of suffocation continuing for months after an apparent injury to the origin of the pneumogastric. In other cases, from lesion of the spinal accessory, spasm of the trapezius and sterno-mastoid muscles, simulating tetanus, may set in."[4]

Treatment.—Any special therapeutic measures seem uncalled for, since, if the lesions are due to blood-extravasations or inflammatory products, nature will suffice to cause their absorption. Mercury, blisterings, etc., are commonly recommended, but I question their efficacy. Iodide of potassium in the later stages may prove beneficial. Electricity, if resorted to at all after head-injuries, must be most cautiously used, and not until a late period if we would not renew the previous cerebral disturbance.

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[1] Two cases are given by Sir C. Bell (Lectures on the Nervous System, Am. ed., p. 202. Cases LXII. and LXV. 1833), where sudden death resulted from secondary displacement of fragments of the occipital bone at the foramen magnum, causing pressure upon the medulla oblongata. These are cited as somewhat analogous cases, since they demonstrate the possibility of secondary displacement of bone being a cause of nerve-compression.

[2] Lancet, Nov. 30, 1878, p. 769.

[3] Agnew, op. cit., vol. i. p. 278.

[4] Erichsen, op. cit., vol. i. p. 551.

SECONDARY AFFECTIONS OF THE BRAIN.

These result quite as often from slight as from severe injuries. They come on at variable periods after the occurrence of the primary lesion. The same may be said with reference to the time of appearance of the symptoms indicative of cerebral complication. Defects of memory are among the most common after-effects of head-injuries, and these may be the sole evidences of cerebral disease, or the amnesia may be associated with other affections. In most instances the patient forgets only recent events, but at times the whole history of his past life is a blank. All power of speaking a well-known language may be lost, the patient using that of his childhood. He may forget his own name, or his residence. Again, the patient may give the most circumstantial and minute account of the way in which he was injured, upon one day, only to contradict it upon the next; and can sometimes be led to say in good faith almost anything that his interrogator pleases, as in a case related by Erichsen. This is of great importance as a medico-legal fact. The patient's disposition may be completely altered, a gentle, quiet demeanor being exchanged for a captious, morose, or quarrelsome temper. Sleep may be broken by frightful dreams. The mind may become generally weakened, so as to be incapable of the slightest exertion. Cephalalgia, vertigo, and tinnitus aurium may also be complained of. Aphasia is a not uncommon occurrence, especially if the anterior cerebral lobes be affected. There may be also agraphia, and loss of the power of articulation. Occasionally the patient loses both memory and speech. All these troubles may be evanescent, but loss of speech and memory is only too apt to be permanent.

INSANITY, apt to be permanent, is a not infrequent sequel of so-called concussion. I have seen one case where, after as long a period as three months of mental alienation, at times so marked as to require bodily restraint, the mind ultimately seemed completely restored. Some few of these cases can be relieved by operation, as in the famous instance recorded by Cline, where, after a depressed fracture of the superior portion of the left parietal bone, trephining, eleven months subsequent to the injury, restored consciousness and voluntary motion.

IMPAIRMENT, DISORDER, OR LOSS OF THE SPECIAL SENSES is quite common, but special sensation may be at times exalted. Instances have been reported, such as those quoted by Prof. Gross, where deafness of long standing has disappeared after severe concussion of the brain.

UNNATURAL SLOWNESS OF THE PULSE, probably due to lesions of the medulla oblongata, the crura cerebri, or the pons Varolii, is an occasional result of concussion of the brain. This cardiac slowing may last for months, the condition coexisting with a peculiar irritability of the heart, so that under excitement the pulse becomes very rapid—again resuming its subnormal rate of frequency upon cessation of mental or other irritation.

CHANGES AFFECTING THE DIGESTIVE ORGANS.—An icteroid hue of the skin is a rare sequel. Nausea and vomiting, or obstinate constipation, have been sometimes noticed to persist for a considerable time after a head-injury. Gross thinks that when obstinate and prolonged gastric distress is present, there has probably been direct involvement of the pneumogastric nerves or their centres. Although the appetite remains good, emaciation and loss of strength, due to defective assimilation, mark the after-course of certain head-injuries.

Urinary Changes.—Cases are met with in which abnormalities of the renal secretion are more or less marked. Thus irritability of the bladder, retention or incontinence of urine, with a marked increase of the amount secreted—that is, traumatic diabetes—may all be noticed. The diabetes mentioned is usually of the saccharine variety, comes on soon after the accident, and persists only for about eight or ten days in most instances. This is not invariably the rule, irritable bladder, etc., with marked diabetes insipidus, sometimes persisting for months. As a result of severe injuries of the skull and brain, albumen, with or without a diminution of urea, may be present in the urine.[1]

The amount of saccharine matter in traumatic diabetes is usually small, and its presence has been variously ascribed to an injury of the floor of the fourth ventricle, to defective oxygenation of the blood, etc.

Genital Changes.—An occasional, early effect of blows upon the head, especially of its posterior portion, has been violent sexual excitement with incessant erections. It appears most probable, according to the latest investigations, that this, as well as impotence, is due to injury of the medulla oblongata, rather than of the cerebellum or cerebrum.[2] Atrophy of the testes may or may not accompany impotence.

Paralysis of some of the facial or ocular muscles is not uncommon. Want of co-ordination of certain muscles, muscular twitchings, and paralysis of a single finger, of the hand, or of a limb, may also occur.

As one of the causes of these various symptoms, Gross calls attention to a calcification and necrosis of the nerve-cells of the brain, described by Virchow, in which the cell-processes and even the fine nerve-fibres of the brain-cortex may sometimes be also calcified, as a result of so-called concussion. In the vast majority of cases, however, the symptoms are due to local congestions or inflammations of various parts of the encephalon, the result of injury to the brain or its envelopes, to intracranial hemorrhages, or to the effusion of inflammatory products, and secondary changes, such as sclerosis. The paralysis may also be due to compression or lesion of the cranial nerves, and not to any cerebral injury proper.

Treatment of Secondary Brain-Affections.—This is involved in that of the injuries which give rise to the secondary results. Over and above this, attention to the state of the bowels, careful regulation of the diet, change of air, and, at a later stage, tonics, hot or cold douches—or alternations of these—with perhaps sea-bathing and electricity, may prove useful. Quietude of mind and body should be enforced. A prolonged course of iodide of potassium, with or without mercury, may be tried. When local congestions seem to be the cause of the symptoms, ergot should be exhibited, and dry or even wet cupping should be resorted to. Prolonged counter-irritation, by setons and issues, has been recommended upon high authority. In conditions of the pathology of which we know so little, such remedies seem to me of doubtful propriety, and having no personal experience of their use I do not recommend, but merely mention them, as said to have proved remedial in the hands of others.

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[1] Albumen, according to Huguenin, is more commonly found in the urine than sugar. A case of Verneuil's, already quoted, presented distinct evidences of both sugar and albumen in the urine.

[2] Harkin, Practitioner, Feb. 1884, p. 98.

MALFORMATIONS AND DISEASES OF THE HEAD.

BY

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DISEASES OF THE SCALP.

ERYSIPELAS.—The head is very frequently the seat of erysipelas. In 692 cases of erysipelas, collected by Zuelzer,[1] the disease was met with on the head in 246 instances. On the scalp it usually assumes the simple cutaneous form, the morbid changes extending no deeper than the aponeurosis of the occipito-frontalis muscle; on the face, however, the subcutaneous structures are almost invariably involved, and great swelling of the parts is produced. Erysipelas of the scalp may also be "cellular" (cellulitis) or "cellulo-cutaneous." Scalp erysipelas usually extends to the face, and face erysipelas to the scalp. Erysipelas of the head may (1) be either idiopathic, or (2) have for a starting-point some wound, ulcer, or chronic skin-disease involving breach of surface. The great bulk of the cases of so-called idiopathic erysipelas occur in this situation, and commence usually on the face, extending subsequently to the scalp. Trousseau[2] and others very rightly question the spontaneous character of this form of erysipelas, and urge that in all but a few cases some slight lesion can be detected—a scratch, or a trifling sore upon the skin, a breach of surface on the nasal mucous membrane, or within the mouth, or the auditory meatus, or even in the lachrymal canal. And with regard to these latter sources of erysipelas, it is to be noted that the reputed idiopathic disease most commonly commences about the orifice of some mucous cavity. Scalp wounds are more commonly followed by erysipelas than are wounds elsewhere. As in other parts, it is most frequent after recent wounds, and more common after small wounds than large. This latter fact is explained by the probable neglect of treatment in smaller wounds.

Symptoms.—These are the same as those of erysipelas elsewhere, with some few modifications.[3] The constitutional disturbance is often considerable, and nausea and vomiting, as concomitant symptoms, appear to be unduly frequent in erysipelas in this situation (Zuelzer[4]). Certain *cerebral symptoms* also commonly appear. Headache, often of severe character, vertigo, drowsiness, or, on the other hand, undue excitement, may be among the earliest constitutional evidences of the disease. As the malady advances, more serious symptoms may supervene, the more usual being sleeplessness, mental confusion, extreme restlessness, or delirium, often of a furious character. These symptoms are usually dependent upon some hyperæmia of the pia mater, and may appear in any form of head erysipelas, independent of cause or extent.

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[1] Ziemssen's Cyclopædia of the Practice of Medicine, vol. ii. p. 457. 1875.

[2] Lectures on Clinical Medicine, 3d ed., vol. ii. p. 253. 1869.

[3] See Vol. I. pp. 177, 184.

[4] Loc. cit., p. 460.

In many fatal cases of head erysipelas with brain symptoms, this hyperæmia has been the only cerebral change noticed at the autopsy. In some cases thrombosis of the cerebral sinuses may occur, producing distinctive symptoms. Nothnagel[1] states that such thrombosis is due to extension from some phlebitis of the surface (scalp or skull). *Meningitis* is rare in erysipelas, and when it does occur is usually suppurative, and due either to metastasis, or more commonly to direct extension of suppurative inflammation from the bones or soft parts. Huguenin has only observed it in cases where suppuration existed. When it occurs it is associated with the usual symptoms—the patient dying with convulsions, paralysis, coma, etc Certain *ocular symptoms* may occur in erysipelas of the head, especially when it involves the orbital region. The most common are conjunctivitis and photophobia, the latter often due to cerebral hyperæmia; in some cases the cornea has ulcerated, and has led to perforation and subsequent wasting of the globe (Wagner). Cases also are recorded of complete suppuration of the globe. In many instances a disturbance of vision exists, which, as a rule, perfectly disappears during convalescence, and is ascribed by Heineke[2] to an œdema of the orbital connective tissue. Amblyopia, neuro-retinitis, and optic atrophy, are reported as occasional sequelæ, the last named being the most frequent.

The *local symptoms* have these peculiarities: The inflammation extends with unusual rapidity; yet, although the entire head and face may be involved, there is little tendency for the erysipelas to extend to the neck or trunk. The manner of extension is very irregular on the scalp, although Pfleger and Zuelzer[3] have endeavored to establish some rules for its extension. If beginning from a wound, it commonly spreads centrifugally, but irregularly so; or, starting from the forehead, it may run transversely around the head to the point of commencement. Over the face it is usually very evenly distributed, the chin, however, remaining nearly always free. The redness is but very little marked on the scalp, owing to the tenseness of that structure and its hairy covering; the swelling also is inconsiderable, and is best noticed at the spreading edge of the erysipelas, where the redness also is best seen. On the face, however, the redness is most conspicuous, and the swelling, especially of the eyelids, often very considerable. Bullæ very rarely occur in scalp erysipelas, but are met with in face erysipelas, especially on the forehead, cheeks, ears, and over the mastoid process. Abscess is a rare sequela, especially on the scalp, and gangrene or sloughing are still more uncommon. In the eyelid, however, both these conditions are sometimes met with in cases that have been severe. The lymphatic glands behind the ear and below the occiput, are very constantly enlarged during the eruption. After the eruption has subsided, the hair usually falls off to a varying extent, but is in time perfectly renewed. Like erysipelas elsewhere, that of the head is liable to relapse and to recur.

Prognosis.—The prognosis is a little more grave than that of erysipelas elsewhere, owing to the probability of cerebral complications, and to the fact that the so-called idiopathic form is apt to occur in unhealthy or debilitated subjects, whose very ill condition has indeed predisposed them to the disease. In the great majority of cases, however, perfect recovery follows. Erichsen's[4] statement that erysipelas of the head, "when arising from wound, is very commonly fatal; when it is idiopathic, it is very seldom indeed followed by death," is certainly not supported by other observers. The *duration* of head erysipelas is, according to Zuelzer (who speaks from a large collection of observations), on the average, 10, 12, or 14 days; less often, 6 days, and still more rarely does it become a matter of weeks.

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[1] Ziemssen's Cyclopædia, vol. xii. p. 212.

[2] Pitha und Billroth, Handb. der Chirurgie, Band iii. 1873. Chirurgische Krankheiten des Kopfes (W. Heineke), S. 2.

[3] For full account see Zuelzer, loc. cit., p. 451 *et seq.*

[4] Science and Art of Surgery, 7th ed., vol. i. p. 701. London, 1877.

Diagnosis.—The diagnosis of facial erysipelas presents no special difficulties, but when on the scalp its recognition is sometimes dubious, owing to the often scarcely noticeable amount of swelling and redness. The constitutional disturbance should arouse suspicion of erysipelas, and an existing injury of the scalp should direct attention to that part, when at the spreading edge the features of the disease would be obvious.

Treatment.—The treatment of head erysipelas presents little that is special.[1] The scalp should be shaved, all wounds kept scrupulously clean, and, as a local application, I should advise the constant use of lead and spirit lotion. The practice of multiple punctures is to be condemned. If any symptoms of cerebral hyperæmia appear, an ice-bag should be applied to the head, bromide of potassium administered, and the case treated on general principles. The eyelids, if they remain swollen, should be carefully examined for abscess, and immediate exit given to the pus, if present.

CELLULITIS.—*Diffuse Phlegmon.*—This term refers to a diffuse inflammation, very commonly erysipelatous, involving the loose layer of connective tissue lying between the aponeurosis of the occipito-frontalis muscle and the pericranium. It is usually due to a wound opening up that layer of loose tissue, but may depend also upon any deep ulceration, upon injuries without breach of surface, that lead to suppuration—for instance, fracture, extravasation of blood, etc.—upon various forms of bone disease inducing suppuration, and, lastly, upon the extension of erysipelas to the deeper parts. It is very doubtful if it is ever spontaneous, although Chassaignac[2] states that it may occur idiopathically during convalescence from cholera.

Symptoms.—About the affected spot a deep-seated swelling of the scalp appears, which extends somewhat rapidly, and is due to effusion in the subaponeurotic tissue. This swelling is at first hard, hot, tender, and painful. As it increases it becomes more brawny, and the parts more evidently œdematous. The extent of the swelling varies, but, as a rule, before it has attained any great size it becomes softer and boggy in spots; the skin, which has up to this time been of normal color (unless erysipelas exists), now becomes reddened; fluctuation, perhaps, is evident; and, at last, pus is discharged. With the evacuation of the pus much of the œdema subsides, and the local symptoms, which are often very severe, become less distressing. These local changes are ushered in and accompanied by symptoms of general disturbance, by rigors which are often repeated, by fever which may run very high, by sickness, headache, and general malaise. Cerebral symptoms, such as occur in erysipelas, may also be present, but, as a rule, all the constitutional symptoms subside considerably when the pus has found an exit. The extent of the local mischief varies. In some cases the whole of the scalp may be lifted up, and appear to rest upon a boggy stratum beneath. Suppuration occurs very early, often in two or three days, and resolution is extremely uncommon. The pus, as a rule, soon finds an outlet, and mostly this is situate in the temporal region or behind the ear, about the inferior limits of the aponeurosis. There are commonly several openings. Sloughs of the connective tissue are discharged or may be removed. Often the aponeurosis itself sloughs in larger or smaller portions, and in some cases the pericranium dies in part, leaving the bone bare, and the condition may be followed by very extensive necrosis. It is remarkable that sloughing of the scalp itself is excessively rare in these cases, no matter how extensive may be its separation from the deeper parts. Facial œdema may exist, but will subside when the pus has had vent.

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[1] See Vol. I. p. 191.

[2] Traité Pratique de la Suppuration, tome ii. p. 7. 1859.

The *prognosis* is often grave, and open to much conjecture. Death frequently occurs, and in the earlier stages is usually due either to purulent infection or to an extension of suppurative inflammation to the meninges of the brain. Death has also occurred from hemorrhage due to the opening of an artery by ulceration.[1] If the disease is, on the other hand, protracted, the prolonged suppuration may cause a fatal issue. The duration and graveness of the case will depend much upon the original cause, the health of the patient, the extent of the suppuration, and the amount of sloughing; but, perhaps, the two most serious local conditions are imperfect discharge for the pus and extensive stripping of the pericranium. The latter condition is noted in a great majority of the fatal cases.

The *diagnosis* can be inferred from the above account. From simple erysipelas, cellulitis is distinguished by the absence of redness, the absence usually of gland enlargement, the greater degree of the local swelling, and the more severe symptoms. Its diagnosis from acute pericranitis, which it may closely resemble, is detailed below.

Treatment.—In addition to the general treatment of diffuse cellular inflammation[2] the head should be shaved, and free incisions made the moment suppuration is suspected, or before that occurrence if the swelling be considerable or very tense. These incisions should be made at the most dependent spots possible, and as near to the attachment of the aponeurosis as the swelling extends. They should be so arranged as to avoid the scalp arteries, and to meet this end some advise radial incisions. Drainage with drainage-tubes should then be carefully and fully carried out, and a poultice applied to the entire scalp. All sloughs should be removed as soon as loose, and when they have all separated the poultice may be discarded for lead and spirit lotion. Throughout the entire case the various sinuses should be well irrigated with a weak carbolic solution at least twice a day, and any new collection of pus at once evacuated. When there is any tendency to bagging, pressure with a Martin's elastic bandage often answers well, but its use requires careful watching, as if applied too tightly it may add to the sloughing action. The drainage-tubes should be removed one by one as soon as the granulating cavity contracts around them, and then gentle pressure with a common bandage may be maintained for some time longer. Often these cases are very tedious, especially when any bone mischief exists; and sometimes (though rarely) the sinuses refuse to heal in spite of the treatment just indicated, and in the absence of any special complication. In one such case that came under my notice, suppuration had continued eighteen months when the accidental discovery of a piece of imbedded drainage-tube, that was supposed to have been removed more than a year before, led to its almost immediate cessation, and to perfect cure. In another case, under my care at the London Hospital, healing was prevented by the formation beneath the aponeurosis of a vast amount of gelatinous, ill-formed connective tissue. On enlarging the sinuses and scraping out this jelly-like matter, a rapid healing ensued. Many cases of protracted suppuration are due to the natural and constant movement of the scalp muscle, which prevents perfect coaptation of the surfaces, as pointed out by Mr. Hilton.[3] He readily cured several chronic cases of this character by simply keeping the muscle at rest by strapping the scalp.

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[1] Follin et Duplay, Traité Élément. de Path. Ext., tome iii. p. 549. 1869.

[2] See Vol. II. p. 675.

[3] For interesting accounts of these cases, see Mr. Hilton's "Rest and Pain," 3d ed., p. 139. 1880.

ABSCESS.—Abscesses of the scalp may be met with in three situations: 1. In the scalp proper, above the aponeurosis; 2. In the lax tissue beneath the aponeurosis; and 3. Beneath the pericranium. Abscesses in the first and second situations are circumscribed, but suppuration beneath the aponeurosis is generally diffuse. Scalp abscesses may be due to many causes, principal among which are contusions, extravasation of blood in the various situations named, retrogressive changes in certain wounds, especially those that have rapidly healed at the surface, the breaking down of syphilitic nodes and of so-called scrofulous deposits, suppurating cysts, and bone affections. Owing to the tension of the parts, scalp abscesses are apt to be associated with severe local symptoms when acute, and with much constitutional disturbance. These acute suppurations are readily diagnosed. A chronic abscess in the scalp may be mistaken for a sebaceous cyst, from which, however, it may be distinguished by its more rapid growth, its pain, its tenderness, its more distinct fluctuation possibly, and by the fact that it would feel to the touch more dense at the periphery than at the centre. A grooved needle, moreover, would clear up all difficulty. There is a form of superficial abscess, common in young scrofulous children, that usually appears as a sequela of chronic eczema. These abscesses are small, often multiple, well circumscribed, and covered by very thin and purple integument. They are, as a rule, painless, and associated with little or no constitutional disturbance. They should be opened early; either by simple puncture, or, better still, by the actual cautery. They sometimes lead to troublesome scrofulous ulcers. Suppuration in the tissue beneath the aponeurosis is apt to assume the character described under cellulitis, although not necessarily of so acute and rapid a course. It is seldom, however, distinctly chronic. Abscesses beneath the pericranium are difficult to diagnose early, and are generally associated with symptoms of bone mischief—necrosis or caries. They will be referred to hereafter.

Mr. Thomas Smith[1] gives an account of a remarkable abscess in a child aged 4 years, that happened to form over a congenital hole in the skull, in the upper occipital region. It assumed the form of a small, rounded, fluctuating tumor, that pulsated but was not reducible. At its base the deficiency in the skull could be felt. Other congenital holes could also be felt in the parietal bones. The abscess was let alone, and ultimately more or less disappeared. This case will be again alluded to in speaking of "Malformations of the skull." Follin and Duplay[2] allude to the great difficulty of diagnosing abscesses situated deeply in the temporal fossa and beneath the temporal muscles. The symptoms of such abscesses are most insidious, vague, and often misleading; fluctuation, even if observable when the muscle is relaxed, is at once lost when the jaws are clenched. It is important that all abscesses of the scalp should be opened early and as soon as detected, and this remark applies very especially to those beneath the pericranium, inasmuch as the longer they are left unopened the more extensively will the pericranium become separated.

ULCERS.—Many various forms of ulcer are met with on the scalp. Some follow upon injuries of various kinds, or upon simple eruptions, such as that of eczema. These require no special notice. The more important ulcers of the scalp are of spontaneous origin, and may be classed as (1) Syphilitic ulcer; (2) Strumous ulcer; (3) Lupus; (4) Rodent ulcer; (5) Epithelioma. Detailed descriptions of these ulcers will be found elsewhere, but the following points that affect their differential diagnosis may be here briefly stated.

(1) *Syphilitic ulcers* are usually limited to the tertiary stage of syphilis, and are most often met with on the forehead. They proceed either from some pre-

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[1] Transactions of the Path. Soc. of London, vol. xvi. p. 224.

[2] Op. cit., tome. iii. p. 550.

existing eruption, commonly rapid, or from the breaking down of a gumma. The general features of these ulcers are that they are of rounded outline, or are annular in figure, or serpiginous; their edges are sharply cut, their bases usually level, and the skin around them of a dusky color that has been well compared to the color of raw ham. Those due to a previous eruption are often multiple, and usually superficial. Those due to gummata are preceded by a hard, irregular, somewhat painful lump, covered by adherent, purplish skin, that in time softens and forms an ulcer, the base of which presents the well-known "wash-leather" or cellular-membranous slough. These ulcers are apt to extend, and often expose the bone, and may then be associated with necrosis. They are all benefited by anti-syphilitic treatment.

(2) *Strumous ulcers* are met with in scrofulous children, and may be on any part of the scalp. There are, as a rule, more than one. They are preceded by a small, hard deposit in the scalp, covered with reddened skin. In time this mass indolently breaks down. The ulcer, when fully formed, is oval or roundish, with thin, undermined, purple edges, and a foul base often covered by exuberant granulations that readily bleed.

(3) *Lupus non-exedens* never occurs primarily on the scalp (Heineke[1]), but may spread thereto from the face, ears, or mastoid region.

(4) *Rodent ulcer* usually appears on the forehead. It is uncommon before 45. The ulcer formed spreads deliberately and very slowly—so slowly that it takes years to effect an amount of destruction that would be accomplished by epithelioma in a less number of months.[2] Its edges are elevated, hard, sinuous, clean, with little adjacent induration, and none of the warty growth of epithelioma. The glands are scarcely ever affected. The bone may be exposed, and so extensively destroyed as to lay bare the dura mater.[3]

(5) *Epithelioma* of the scalp is rare, and most commonly appears on the skin of the forehead or frontal region. The ulcer formed grows rapidly, has indurated, everted, and most irregular, warty edges, and often an equally irregular base. Unlike rodent ulcer, it invades the glands, and, unlike the syphilitic ulcer, it is single.

With regard to the general *prognosis* of scalp ulcers, it must be remembered that any extensive or deep ulceration may cause death from cerebral complication, usually by inducing a thrombosis of the cerebral sinuses, or a meningitis of the convexity.

The *treatment* of these ulcers calls for no special mention in this place. Birkett records a case[4] of successful removal of a large epitheliomatous ulcer over the right temple. Holmes relates a case[5] in which he removed from the fronto-parietal region of a man aged 64, an epitheliomatous ulcer three and a quarter inches in diameter. The pericranium was exposed. The man died shortly after the operation with cerebral symptoms.

ANTHRAX.—This is extremely rare in the scalp. When it does occur, it is usually met with in the inferior occipital region, and is due to extension from the neck. The next most usual situation is the forehead. Anthrax of the scalp is especially dangerous by its tendency to induce cerebral complications. This is usually effected by a thrombosis of the sinus, produced by an extension of phlebitis from without. This thrombosis is then apt to end in purulent "phlebitis sinuum." Nothnagel[6] gives an excellent account of such cases. Purulent meningitis of the convexity may also, according to Huguenin,[1] be induced in a like manner. Sir Astley Cooper[2] "never saw a patient who recovered from any considerable carbuncle on the head." Since that statement was made, cases of recovery have, however, been recorded. I saw two years ago an extensive anthrax, involving the greater part of the forehead, that in time healed perfectly, with but trifling constitutional disturbance.

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[1] Heineke, loc. cit., S. 8.

[2] Hutchinson, Illustrations of Clinical Society, vol. i. p. 14.

[3] Erichsen (Science and Art of Surgery, 7th edit. vol. i.) gives a cut showing very extensive exposure of the dura mater in a man who had been afflicted with the disease for thirty years.

[4] Trans. of Path. Soc. of London, vol. xix. p. 389.

[5] Ibid., vol. xxiii. p. 277.

[6] Ziemssen's Cyclopædia of the Practice of Medicine, vol. xii. 221.

GANGRENE.—More or less extensive gangrene of the scalp may follow severe injuries, especially in the cachectic. I have seen extensive gangrene of the scalp over the frontal and occipital regions follow upon the application of a tight bandage. This had been applied to arrest bleeding from a frontal scalp wound, the patient being an intemperate, ill-conditioned woman, past middle life. Gangrene of the scalp may also follow upon diffuse cellular inflammation of the scalp, especially if the treatment by prompt incision be neglected. Sir Prescott Hewett,[3] however, mentions a case of very considerable gangrene following cellulitis where early incision had been made. The patient was a woman of middle age, and the case ended fatally. Heineke[4] states that in feeble, unhealthy children a very trivial cause may induce a partial scalp gangrene. It has occurred after slight injuries, after otitis externa, after eczema behind the ear, and after erysipelas. Mr. Thomas Smith[5] has described an unique case in a little girl, aged nine. After an attack of erysipelas, a large piece of the left parietal bone came away by spontaneous necrosis, bringing with it a corresponding portion of the hairy scalp. The case did well. The treatment of gangrene in this situation requires no especial notice.

TUMORS OF THE SCALP.—In addition to those tumors described below under the special headings "Pneumatocele," "Hæmatoma," "Cysts," "Horns," "Vascular Tumors," and "Aneurism," the following growths are met with in the soft parts that cover in the cranium.

Fatty Tumors.—These are very rare. They may occur on any part of the scalp, and, although as a rule small, may attain a considerable size, and may even become pedunculated.[6] In some cases they are congenital, or are at least noticed very early in life.[7] Their origin—in most cases at least—appears to be from the loose connective tissue beneath the scalp aponeurosis, and they are frequently found to be adherent to the pericranium. As a rule, their growth is very slow, although in one case[7] the tumor reached the size of half an orange in eighteen months. When of large size the diagnosis is very simple; but when small and beneath the aponeurosis the diagnosis is difficult, the mass often feeling very hard and adherent. In Mr. Sydney Jones's case the mass appeared to become tighter and more prominent when the child cried. These tumors give no trouble other than by their bulk, although some time ago I removed a small fatty tumor from beneath the frontalis muscle in a woman, aged thirty-one, that had been associated with intense neuralgia of the supraorbital nerve. The tumor was directly over the nerve. If these growths give any inconvenience they should be excised at once.

Fibrous tumors are also very rare unless they appear as the tumors of molluscum fibrosum, which are, however, as a rule, more of a fibro-cellular structure, and are not infrequent on the scalp. Sir Prescott Hewett[1] and Professor Gross[2] both describe cases of large fibrous tumors of the scalp, in each instance about the size of an orange. In Hewett's case, the mass was behind the ear, and hung down by a thick pedicle. In the other case the tumor was on the vertex. In both instances the fundus of the mass had ulcerated. Such tumors as these are readily removed if they occasion any trouble.

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[1] Ibid., p. 603.

[2] Lectures on Surgery, vol. i. p. 243.

[3] Lectures on Injuries and Diseases of the Head. Medical Times and Gazette, vol. ii. p. 200. 1855.

[4] Loc. cit., S. 8.

[5] Trans. of Clin. Soc. of London, vol. iii. p. 163. 1870.

[6] Bruns, Handb. der prakt. Chirurgie, Bd. i. S. 96. 1854.

[7] Case recorded by Mr. Sydney Jones. The tumor was first noticed when the child was two months old. Lancet, Oct. 1880, p. 587.

Pachydermatocele ; Elephantiasis of the Scalp ; Hypertrophy of the Scalp.—A remarkable condition of the scalp has been described by different authors under one or other of these titles.[3] There is now no doubt, however, that these terms have all been applied to one and the same disease. The disease consists in a remarkable overgrowth of the scalp tissues at some one spot. The mass thus formed hangs down as a huge, pendulous, bag-like tumor, often lobulated and thrown into transverse folds or creases, doughy and flabby to the feel, quite painless, and covered by normal skin. Dr. Mott, who gives an excellent account of these tumors, says that they are always congenital, and begin in a mole. Subsequent authors have, however, not confirmed this statement.[4] These masses have occurred most frequently about the age of puberty and in young adults. In females they are more common about the occiput ;[5] in males about the temporal or parietal region. They grow slowly, and are innocent, causing trouble only by their bulk, which may be considerable. When they hang down from the temple, they close in the eye and drag down the mouth. In a case recorded by Sir E. Home, the tumor was larger than the patient's head.[6] With regard to *treatment*, Thirion[7] obtained a cure by the use of continued pressure and iodine applications ; but no doubt the bulk of such cases must be treated by removal, if treated at all. One case so operated on was fatal from hemorrhage,[8] and in one of Dr. Mott's cases[9] the mass recurred twice, a circumstance explained by its imperfect removal in the first instance. Each operation must be planned to meet the particular case. If great bleeding be anticipated, the common carotid may be tied as a preliminary measure.

Osteoma.—Virchow[10] records two cases of osteoma of the scalp, in patients respectively forty-eight and sixty-seven years of age. They had existed for a long time. These cases, however, were only examined clinically, and may be fairly open to question as to their real nature.

Papillomata of the scalp are extremely rare. They are probably always congenital, and commence from a minute wart or mole. They are most common about the frontal region, and present precisely the ordinary aspect of papillomata elsewhere. In a woman aged thirty-five, under my care at the London Hospital, there was a papilloma, measuring 3½ inches by 3 inches, over the coronal suture just to the right of the middle line. It had grown from a minute mole. It was very prominent, slightly pedunculated, and gave issue to a thin discharge, having the peculiarly offensive odor of papillomata elsewhere. It was absolutely devoid of hair, and had the usual cauliflower aspect. As the hair had always been combed over the mass, its surface was flatter than is usual in these growths. The *treatment* should be the same as that for papillomata in other situations.

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[1] Medical Times and Gazette, vol. i. p. 315. 1862.

[2] System of Surgery, 5th ed., vol. ii. p. 115.

[3] For some collected cases, see Bruns, Handb. der prakt. Chirurgie, Bd. i. S. 91 ; also a paper by Dr. Valentine Mott (Med.-Chir. Trans., vol. xxxvii. p. 154), including excellent drawings of the disease, and records of five cases—two being situate on the scalp. An excellent case will also be found in the Clinical Society's Transactions, Nov. 1876, reported by Mr. Walsham.

[4] See, however, Gross, op. cit.

[5] Follin et Duplay, Traité de Path. Ext., tome iii. p. 569. 1869.

[6] See drawing in Med. Times and Gazette, vol. i. p. 315. 1862.

[7] Revue Méd.-Chir., tome ii. p. 100. 1852.

[8] Case quoted by Erichsen. Science and Art of Surgery, vol. ii. p. 384. 1872.

[9] Loc. cit., p. 156.

[10] Die krankhaften Geschwülste, Bd. ii. S. 65. 1864.

Sarcoma of the scalp is occasionally met with, although more usually the disease commences in the bone or in the dura mater (" fungus"). It appears to be usually of the spindle-celled variety, and to present the usual signs that distinguish sarcomatous growths elsewhere. Neither the *diagnosis* nor the *treatment* calls for any especial notice in this place.

Carcinoma usually assumes the form of epithelioma.[1] MM. Follin and Duplay[2] state that a malignant growth may appear in the deeper parts of the scalp having all the characters of scirrhus.

Solid Congenital Tumors.—In addition to the congenital dermoid cysts, certain solid congenital tumors are sometimes met with in the scalp. They are, as a rule, deeply seated, and adherent to the pericranium. In a case of Mr. Thomas Smith's, quoted by Holmes,[3] the tumor was 2 inches by 1 inch in size, and was lobulated, hard, and purely fibrous in structure. Some of the less superficial tumors contain cysts, while those nearer the surface are quite solid. These growths appear to have the same general structure as have like congenital tumors elsewhere.

Pneumatocele.—This term is applied to tumors formed by a collection of air beneath the pericranium, and due to a spontaneous perforation of the mastoid cells, or of the frontal sinus. To appreciate its exact nature, it is necessary to exclude from consideration all emphysematous tumors of the scalp.

Emphysema of the scalp may occur in connection with a more general emphysema of the cellular tissue of the body, or may be due to the decomposition of retained inflammatory products. *Localized emphysematous tumors* may also be due to fractures of the frontal, nasal, or ethmoid bones, and, also, according to Leduard,[4] to a fracture of the temporal bone—in any such case a cavity containing air being opened up. Such tumors may also be due to necrosis of the frontal bone (Warren,[5] Duverney[6]), or to like disease in the mastoid process (Prescott Hewett[7]). These tumors must not be confused with pneumatocele.

Only ten cases of pneumatocele have been put on record;[8] of this number, nine occurred in the mastoid region, and are stated to have been due to opening up of the mastoid cells, and only one has been met with in the frontal region.[9] Nine of the ten cases occurred in males. The average age of the patients was about thirty, the youngest being eighteen,[10] the oldest forty-seven.[11]

Symptoms.—When in the mastoid region, the tumor is situated behind the ear, although in Balassa's case it first appeared in the temporal region. Jarjavay's case was situated at the outer border of the orbit. Pneumatocele begins as a small, hard, rounded tumor, of regular outline, and covered by normal skin. Its distinguishing feature is that it is resonant on percussion. By pressure, the tumor, when not too large, can be entirely emptied, this reduction being often accompanied by a hissing sound in the ear. In Chavance's case the membrana tympani had been ruptured, and on applying pressure to the tumor air issued from the ear with a whistling noise. In the frontal pneumatocele, a like hissing sound could be heard on auscultation when attempts were made to reduce the mass. Forcible expiratory efforts often increase the size of the tumor. Pneumatocele is painless and causes no inconvenience, although in a few cases it has been associated with pain in the part, some deafness, vertigo, and sickness. These symptoms are increased or induced by pressure on the tumor. In one case (Lloyd's) there was paralysis of the arm, and in the frontal tumor the sense of smell had been lost.

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[1] See page 116 *supra*.

[2] Op. cit., tome iii. p. 570.

[3] Surgical Treatment of Children's Diseases, p. 28. 1868.

[4] Quoted by Heineke, op. cit., S. 10.

[5] J. M. Warren, Surgical Observations, chapter xiii. Boston, 1867.

[6] Quoted by Heineke, loc. cit., S. 15.

[7] Lectures on Diseases and Injuries of the Head. Med. Times and Gaz., vol. ii. p. 106. 1855.

[8] An excellent abstract of all these cases will be found in Heineke's monograph, S. 11 u. folg. See, also, Costes, Moniteur des Hôpitaux, tome vii. Nos. 21–24. 1859; Louis Thomas, Du Pneumatocèle du Crâne. Thèse de Paris, 1865; and M. Gayraud, Art. Crâne, Dict. Encyc. des Sci. Méd. 1879.

[9] Jarjavay's Case, Compendium de Chir. pratique, t. iii. p. 100.

[10] Balassa, Tumeur Emph. du Crâne. Revue Méd.-Chir., 1854.

[11] Voison, Du Pneumatocèle du Crâne. Thèse de Paris, 1860.

The *progress* of pneumatocele is very slow, being usually a matter of years. The tumor steadily increases in size, although in one case (Lloyd's) it trebled its dimensions in two days. It often attains large size, occupying one-half of the vault of the skull. Such large tumors are scarcely, if at all, affected by pressure. Pneumatocele shows no tendency to spontaneous cure, and at the same time a fatal issue has never occurred directly from this affection. The *prognosis*, therefore, is favorable.

Anatomy.—The air in these cases is always beneath the pericranium, and is derived from the mastoid cells or frontal sinus by spontaneous perforation of the bone covering those cavities. Chemical analysis shows this air to be somewhat modified in composition, its oxygen being diminished, its nitrogen and carbonic acid increased. These changes are similar to those noted in analyses of the gaseous matter obtained from cases of ordinary surgical emphysema. It is unnecessary to observe that the mastoid cells communicate with the middle ear, and the frontal sinus with the nasal cavity. The pericranium in these cases is of normal aspect, and the extent of the tumor is always found to be limited by the attachments of this membrane. The bone which underlies these tumors, and which is exposed when they are opened up, presents always a remarkable alteration. It is found to be extremely rough, and to present many irregular elevations and depressions; and so large are these bosses or elevations in some cases, that they can be felt through the integuments when the contents of the tumor have been removed by pressure. The cause of this remarkable change is unknown. It is coextensive with the separation of the pericranium; and it is stated that the bony irregularities disappear when the pericranium again becomes adherent to the skull, a condition that obtains in cases of cure. Apertures are observed in the exposed bone, and although there is no doubt that some at least of these communicate with the sinuses of the affected part, yet this communication has not been actually demonstrated in the only two cases which have been examined after death.[1] The evidence of this communication depends upon clinical observation, and is, I imagine, indisputable.

The *causes* of pneumatoceles are still most obscure. It is acknowledged that they are due to a spontaneous perforation of the bone covering an air-containing cell or sinus, but how that perforation is brought about is still unknown. Injury appears to be no factor in its production. In only one of the ten cases known to surgeons can a traumatism be fairly considered to have had any real concern in the etiology. It is probable, therefore, that the perforation is brought about either by a localized and progressive atrophy of the bone, or by the destructive action of caries sicca.[2] The atrophic theory is supported by a comparison between this affection and the changes that occur sometimes in the skulls of old people whereby perforations in the vault are produced.[1] Hyrtl,[2] moreover, has shown that the air cavities of the skull may undergo great enlargement by the gradual atrophy of their walls; but as to the cause of that atrophy nothing is known. Many facts support the theory that the perforation is due to caries sicca. The pain and other symptoms often associated with the disease would bear upon this point, as would also the condition of the bone itself. It is maintained,[3] however, that the irregularities on the surface of the bone are subsequent to the separation of the pericranium, but I would urge that this relation has not yet been satisfactorily demonstrated.

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[1] Lecat, Recueil des Actes de la Soc. de Santé de Lyon, tome i. p. 31. 1798; and Fleury, Observat. de pneumat., Bull. de la. Soc. de Chir., 2e série, tome viii. p. 520. Paris, 1867.

[2] Heineke, loc. cit., S. 14.

The *treatment* of pneumatocele should, in most cases, be merely palliative, and may consist of gentle and constant pressure upon the mass, maintained by a suitable pad and an elastic bandage, or, if on account of troublesome symptoms, or for other reasons, more active measures are called for, the tumor may be reduced, or if irreducible, emptied by a fine trocar, and then firm pressure kept up over the site of the tumor for a number of weeks. In Denonvillier's case, the mass was very much reduced in size in fifty days. Many of the recorded cases were treated by incision, a treatment that must be strongly condemned. For in each case so treated, severe suppuration followed, and in two cases led to a fatal issue—by pyæmia in Lecat's case, and by extension of the inflammation to the brain in that of Fleury's patient.

HÆMATOMA.—As far as the external soft parts of the head are concerned, collections of blood may be formed in three situations: 1. Above the aponeurosis, in the substance of the true scalp. (Hæmatomata in this situation are generally small and circumscribed.) 2. Below the aponeurosis, in the loose connective tissue that separates it from pericranium. (These blood collections are generally extensive and diffuse.) 3. Beneath the pericranium. It is to blood tumors only in this last situation that the term *cephalhæmatoma* is applied. Under the generic term of hæmatoma may also conveniently be considered certain remarkable blood tumors that communicate with the intracranial venous circulation.

Simple Hæmatomata of the Scalp.—Simple collections of blood situated either in the true scalp or in the connective tissue beneath its aponeurosis, require no especial mention in this place. They are the results of injury, and an account of the general history and treatment of such collections will be found elsewhere.

One word, however, may be said with regard to extensive blood collections beneath the aponeurosis in children. These may involve nearly the whole vault, being limited solely by the attachments of the aponeurosis, and may attain an immense size. So extensive may these blood tumors be, that they may simulate hydrocephalus;[4] from which affection, however, they may readily be distinguished by their history, by the absence of the characteristic shape of the forehead, and by the fact that the normal skull may be felt beneath the collection of fluid. Such large extravasations are most frequent in cachectic children, and often follow upon apparently very trifling injuries.[5]

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[1] Vide *infra*, Atrophy of Skull.

[2] Hyrtl, De la déhiscence spontanée de la route du tympan et des cellules mastoidiennes. Comptes rendus de l'Acad. des Sciences, tome xxx, No. 10. 1858.

[3] Gayraud, Art. "Crâne." Dict. Encycl. des Sc. Méd., p. 538. 1879.

[4] Holmes, Art. Regional Surgery. System of Surgery, 2d ed., vol. v. p. 963.

[5] See a remarkable case in a boy of eight years, reported by Dr. James Finlayson; the tumor was so large as to simulate hydrocephalus, and there was no direct history of injury. The case proved fatal. Glasgow Med. Journal, 1880, p. 190.

CEPHALHÆMATOMA.—This term is limited to blood tumors formed between the pericranium and the bone, and occurring in newly-born children. These tumors are very rare. In observations made at the Hospice de la Charité de Marseille, Seux[1] met with only 19 cases of cephalhæmatoma in 5674 newly-born children—a proportion of about 1 in 298. Bouchacourt,[2] from the collected statistics of other observers, gives the proportion as 1 in 250 newly-born children.

Cephalhæmatoma is much more common in male than in female children, and is said to be somewhat more frequent in the children of primiparæ than in others.

Seat.—The great majority of these tumors are situated on the parietal bones, and more often on the right side than on the left. They generally occupy the posterior superior angle of the bone. Elsewhere they are very rare. A few have been met with over the occipital bone, still fewer over the frontal, and none on the temporal bone. There may be one, or even more than one, on each parietal.

Anatomy.—The pericranium inclosing the extravasated blood is quite unaltered, except under certain circumstances, to be hereafter mentioned. The subjacent bone usually presents a normal aspect, although in cases of long standing it may become rough by a deposit of new bone upon its surface.[3] In some rare cases it may be thinned, and, still more rarely, perforated.[4] The contained blood may be fluid, and coagulate on removal; but more usually it is found more or less coagulated, and of jelly-like consistence. Sometimes it appears to be inclosed in a kind of pseudo-membrane. Before it has existed long, and generally within a week, certain changes take place at the extreme periphery of the tumor, which finally result in the mass being encircled in an osseous ring or "*bourrelet.*" This osseous circle is typical of cephalhæmatoma. It occupies precisely the angle formed at the spot where the pericranium actually leaves the bone, and as that surface of the long ring which looks towards the blood collection is perpendicular to the plane of the skull, it will be seen that this *bourrelet* will in transverse section present a triangular outline.[5] The bony matter of the ring is easily separated from the subjacent bone, which then appears normal. Similar formations of bone are observed in rabbits subjected to experimental elevation of the pericranium.[6] As the cephalhæmatoma subsides, the osseous circle disappears, and in time leaves not the least trace of its existence. In certain cases, more especially in those of old standing, a thin layer of bone forms beneath the separated pericranium, and a tumor so modified often crackles under the finger like tinsel.[7]

Causes.—Valleix,[8] and also Paul Dubois,[9] have shown that, in the newly-born, the external table of the skull is porous, vascular, incomplete, and partially absent. The diploic vessels, therefore, are almost exposed; and it is easy to understand that even a trifling pressure applied to the yielding head of an infant, during delivery, may cause the pericranium to glide upon the subjacent bone, and, by a slight injury to vascular connections, produce a hemorrhage. Bouchacourt's[10] researches show that at the base of the common swellings of the head in the newly-born, a slight subpericranial hemorrhage is almost invariably to be found. A little pressure of the head upon the pelvis of the mother, or, as some would urge, the contractions of the uterus itself upon the head, may provide all the force required to produce a cephalhæmatoma. It is well known that this blood tumor occurs in children delivered by the very easiest form of labor, and that it has been observed also in cases of breech or foot presentation. Some, therefore, insist on a spontaneous or even an intra-uterine cause for this affection. I think, however, that it may be safely ascribed to injury—however trifling—inflicted during birth.

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[1] Seux, Recherches sur les Maladies des Enfants Nouveaux-nés. Paris, 1863.

[2] A. Bouchacourt, Nouveau Dict. de Méd. et de Chir. Prat., Art. Céphalématome. 1873.

[3] West, Diseases of Infancy and Childhood, 6th ed., p. 59. 1874.

[4] Follin et Duplay, Traité de Path. Ext., tome iii. p. 556. 1869.

[5] A good drawing to show this osseous ring is figured by Follin and Duplay, op. cit., p. 558.

[6] Bouchacourt, loc. cit., p. 5.

[7] This change is well described in South's edition of Chelius's "Surgery," vol. ii. p. 449.

[8] Valleix, Clinique des Malades des Enfants Nouveaux nés, p. 494. Paris, 1839.

[9] Dict. de Médecine, etc., 2e éd. (Dict. en 30), Art. Céphalématome.

[10] Bouchacourt, loc. cit., p. 6.

Symptoms—Cephalhæmatoma is little noticed at birth, but usually appears within forty-eight hours. When first observed it is generally about the size of a hazelnut; it gradually increases, and in a few days may be the size of a chestnut. Some cephalhæmatomata have been as large as hens' eggs, and Chelius says that they may involve the whole parietal bone. The tumor is circumscribed, soft, elastic, slightly fluctuating, and painless. The skin over it is normal, or a trifle discolored, if some days have elapsed; or tense, if the tumor has grown quickly. The tumors are always precisely limited by the pericranium, and, therefore, never extend beyond a suture, a feature of value in diagnosis. In a few days a tolerably hard ring can be felt around the soft tumor. This is probably due to partial coagulation, and is soon replaced by a quite hard ring, which, as above stated, is actually osseous. Sometimes too the crackling on pressure, due to subpericranial ossification, can be appreciated. Having attained certain dimensions, the tumor begins to subside. As it becomes more flaccid, the bony circle becomes more distinct, and is the last component of the tumor to disappear.

These tumors do not pulsate, except in those very rare cases in which a neighboring artery gives some feeble impulse to the mass, or in which a communicating internal cephalhæmatoma exists.

In the *diagnosis* of cephalhæmatoma, the chief points are its time of appearing, its tendency to increase, its elastic character, its osseous ring, and the precision with which the tumor is limited to one bone.

The *prognosis* is most favorable. In the great majority of cases, spontaneous cure follows in from fifteen days to two months from the date of appearance of the tumor. In a few cases suppuration has followed, and in still less frequent instances, caries or necrosis of the subjacent bone is recorded.

The *treatment* of cephalhæmatoma simply consists in letting the tumor alone. Interference of any kind is useless, if not harmful. If, however, it should at any time become painful, or if it should persist for more than two months, and still appear soft, the mass may be aspirated, and firm pressure applied. Discutients, pressure, the seton, cautery, and incision, are simply mentioned to be condemned.

INTERNAL CEPHALHÆMATOMA.—This term has been applied to hemorrhages between the dura mater and the bone observed in the newly born. It is impossible to diagnose this condition during life, and it presents no practical interest. Sometimes, however, a hemorrhage in this situation may coincide with an external cephalhæmatoma, and not infrequently the two blood tumors have communicated through a fissure in the bone, whereby pulsation has been given to the superficial mass. Such tumors are, however, very rare, and, as a rule, soon end fatally. They may be mistaken for meningoceles, from which tumors they may be distinguished by the fact that they are small, flat, without pedicle, and quite opaque, and that they are usually situated on the parietal bone where meningoceles do not occur.

The "*céphalématome des femmes*" of French authors refers to a tumor said to occur in the scalp of women and young girls, and to be associated with retarded menstruation.

BLOOD-TUMORS OF THE SCALP IN COMMUNICATION WITH THE INTRACRANIAL VENOUS CIRCULATION.[1]—These tumors are very rare, and consist essentially of a collection of venous blood beneath the pericranium, communicating by an aperture in the bone with the superior longitudinal sinus. Communications with no other intracranial veins have been actually made out, although Dupont has endeavored to prove that in some cases the communication is with the diploic veins. The communication with the sinus may be either effected by an injury or spontaneous. Pott[2] gives an excellent example of the former mode of causation. A splinter of bone having been driven into the superior longitudinal sinus without laceration of the skin, a typical blood-tumor was the result. As to how the spontaneous perforation of the bone is effected, nothing certain is known. Many theories have been advanced, some urging that the perforation is the result of atrophy in a Pacchionian depression, others that it is due to bone-disease, and others that it is brought about by means of a varicose emissary vein. The blood is, in the first instance at least, beneath the pericranium; but in some cases it may come through that membrane and appear beneath the skin. If the case be due to injury, one crack or fissure in the bone will be found to maintain the abnormal communication; but in cases of spontaneous perforation many holes are generally found, some of them very minute. Apart from these apertures the bone as a rule presents a normal aspect. In some cases a slight peripheral ring of bone exists like that found in cephalhæmatoma.

Symptoms.—Most of the cases are met with in the frontal region, a few in the parietal, and very few, indeed, in the occipital region.[3] In all instances they are about the line of the sinus. So little trouble do these tumors occasion, that they are generally discovered by accident. They are never large, being, as a rule, about the size of a chestnut; are round and soft; possess distinctly fluid contents; and are covered either by normal skin or by a thinned and purple integument. They are reducible by pressure, either wholly or in part, and, when reduced, the perforation in the skull may sometimes be detected, and a return of the mass prevented for a time by applying the finger to the bone. They can be increased in size by coughing, by stooping the head, and by compressing the internal jugular veins in the neck. In certain rare cases "a dull kind of pulsation" (as Pott expresses it) can be felt. A bruit is never present. These blood tumors show little tendency to increase, and less to undergo spontaneous cure. In a few instances they cause some pain and vertigo (increased by pressure), but as a rule they give no trouble.

The *prognosis*, therefore, is perfectly favorable as long as these tumors escape injury.

Diagnosis.—To diagnose these tumors from varices of the superficial veins, a ring of ivory or lead is made use of. This is placed on the head so as to encircle the tumor, and is pressed firmly down against the scalp. A simple varicose vein cannot be reduced in size while the ring is on, whereas its presence will not at all influence the reduction of the blood tumor. These collections may be distinguished from collections of pus, which, being situated both within and without the cranium, communicate through a hole in the bone, by the absence of any previous inflammation or evidence of bone-disease.

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[1] An excellent account is given of these tumors by Dupont (Thèse de Paris, 1858, No. 78), and also by Hermann Demme (Virchow's Archiv, Band xxii. H. 1, 2. 1861.); the latter author attempts to divide these tumors into three distinct categories. See also article "Crâne" by Dr. Gayraud, in the Dict. Encyclop. des Sc. Méd., p. 544. 1879. Dufour (Comptes Rend. de la Soc. de Biologie, le série, tome iii. p. 155. Paris, 1851), and Hutin (Mémoires de Méd. de Chir. et de Phar. Militaires, 2e série, tome xiv. Paris, 1854), record post-mortem examinations.

[2] The Chirurgical Works of Percival Pott, vol. i. p. 156. London, 1808.

[3] See, however, cases by Flint (New England Journ. of Med., vol. ix. p. 112), and by J. W. Ogle (British and Foreign Med.-Chir. Review, vol. xxxvi. p. 212. 1865).

No *treatment* is needed. All that is required is that the tumor shall be protected by a well-fitting plate of gutta-percha or metal. Perhaps pressure may be tried. Any operative procedure would be almost unjustifiable, considering the immediate connection of the tumor with the interior of the cranium.

CYSTS OF THE SCALP.—The true cysts of the scalp include common sebaceous cysts, congenital or dermoid cysts, and serous cysts. With the common sebaceous cysts will also be considered, for convenience sake, *follicular ulcers of the scalp*, and *horns*.

I. THE COMMON SEBACEOUS OR FOLLICULAR CYST.—*Anatomy.*—These cysts form the very commonest tumors of the scalp, and are popularly known as "wens." As regards their nature they may be classed as retention-cysts, being due, for the most part at least, to an accumulation of secretion in the sebaceous follicles of the skin. A large number of them show on their surface a black spot which represents the still patent orifice of the greatly distended follicle. Some, however, show no such orifice, and these have been considered to be derived from abortive follicles—from follicles imperfectly developed, and that probably have never contained a hair, and have never opened upon the skin. The cyst wall is generally distinct and well formed; at first thin and pliant, it may become in time thicker and more firm. It has a distinct lining of squamous epithelium, and it is important to note that between this lining epithelium and the epithelial contents there is no line of distinct demarcation.[1] The contents of the cysts vary. In what may be regarded as their most typical state, they consist of layers of soft, white, epidermic scales, that show evidence of softening about the centre of the mass. Such is the appearance in young cysts, but in long-standing tumors the nature of the contents varies considerably. They may be wholly pultaceous, or the centre may be pultaceous while the epidermic matter at the periphery has from pressure become so hard as to appear like a distinct, laminated, horny layer. In this way are formed what are incorrectly known as "thick-walled cysts:" the thickness of the wall is due to no changes in the thin wall or capsule, but simply to lamination of the contents. Portions of the horny matter which form the so-called "walls" of these cysts may be detached and lie loose among the softer contents, and such hard masses may sometimes be distinctly felt through the integument.[2] At other times the contents may be almost or quite fluid, and may even, according to Sir Prescott Hewett, become transparent. Or they may be discolored by admixture with blood, or may contain much cholesterin (cholesteatoma). Lastly, the contents may become firm and putty-like, or cretaceous, and according to Heineke[3] a peculiar ossification of the whole mass may be met with. This last observer says that calcification is not uncommon in the smaller cysts.

These tumors are situated primarily in the subdermic tissues between the skin and the aponeurosis of the scalp muscle, and have at first but a loose connection with adjacent parts, so that they may be almost made to roll under the skin. They soon become more adherent, especially if inflamed at any time. The skin covering them, although at first normal, becomes thinned, pinkish, and more or less bald. And, on the other hand, progressing deeply, the cyst, if large, often comes in contact with the skull. It is now generally allowed that this form of sebaceous cyst does not affect the subjacent bone, and never causes perforation.[1] The very utmost change which it may produce is to form a trifling depression on the surface of the skull, and this even is denied by some.

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[1] Cornil et Ranvier, Manuel d'Histologie Pathologique, 2e éd., tome i. p. 350. 1881.

[2] Hewett, Sebaceous Tumors of the Cranial Region. St. George's Hosp. Reports, vol. iv. p. 96. 1869.

[3] Loc. cit., S. 37. He believes the ossification to take place through a connective-tissue formation that appears among the epithelium.

Of the *etiology* of these cysts, little is known. They are often distinctly hereditary, are more common in women than in men, and usually appear first in youth and early adult life. They are much more frequent upon the hairy scalp than upon the forehead and temples, and often *appear* to be produced by injuries or by erysipelas of the scalp. When on the scalp they are often multiple. Prof. Gross alludes to the case of a man who had some two hundred of these tumors on his scalp.[2]

Progress and Termination.—The rate of growth is usually very slow, and generally a matter of years. It varies, however, considerably. At any period the cyst may remain stationary for an indefinite time. As a rule, these tumors do not attain a great size. The largest, however, are met with on the scalp, and usually at the posterior part of the scalp, and here they may attain enormous dimensions. On the brow they seldom, if ever, attain a large size. The skin may rupture spontaneously and give exit to the cyst, although this is more usually the result of injury. At any time the cyst may suppurate. Such suppuration is usually most tedious, a sinus resulting that for an indefinite time discharges a thin pus mixed with the fetid contents of the cyst. Extensive ulceration may follow, and a so-called "fungating or follicular ulcer" be produced.[3] From a peculiar growth of epithelium from its exposed lining membrane, "horns" may be formed.[4] Cases of entire absorption or disappearance of sebaceous cysts have been recorded. I had under my care recently a woman in whom this had occurred. The cyst was the size of a large marble.

The *diagnosis* is easy, and may be gathered from the preceding remarks. "The chief points to be looked to, in addition to those that are common to all cysts, are their immediately subcutaneous situation; their regular, smooth, round, or oval form, which may in some instances be made to change by pressure when the contents are of a soft substance that may be moulded into various shapes; the easy mobility; the dark central point; the hereditary origin; the slow growth; the healthiness of the immediately surrounding parts; the absence of change in them from the pulse or respiration, and of head symptoms when they are pressed."[5]

Treatment.—The only treatment is that by excision. As a rule the cysts on the scalp shell out very readily. Sometimes, if small, the cyst can be removed entire with very little dissecting. If any difficulty be experienced, the tumor may be transfixed, and the cyst then forcibly pulled out with forceps. It is essential that every portion of the cyst-wall should be removed. On no account should an attempt be made to remove a sebaceous cyst while in a state of acute inflammation. If it be inflamed, a simple puncture should be made into the cyst, a poultice applied, and further operation left until the more urgent inflammatory symptoms have subsided. If the cyst be very large, it may be necessary to remove some of the redundant skin. If, for any reason, a portion of the cyst-wall should be left behind after attempted excision, the epithelial surface should be well rubbed with solid nitrate of silver to destroy the secreting elements, and the wound should be dressed for a while from the bottom. Considering the frequency of the operation of excision, and the little after-attention which the wound generally receives, it is a proceeding no more frequently followed by ill consequences than the infliction of any other simple wound.

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[1] See an intesting discussion before the Surgical Society of Ireland, April 6, 1866, opened by Dr. B. Wills Richardson.

[2] System of Surgery, 5th ed., vol. ii. p. 114. Philadelphia, 1877.

[3] See page 127.

[4] See page 127.

[5] Holmes's System of Surgery, 2d ed., vol. i. p. 517. Art. "Tumors," by Sir James Paget and Mr. C. H. Moore.

Follicular or Fungating Ulcer.—This term is given to an ulcer sometimes formed by the breaking down of one of these sebaceous cysts. The skin over the cyst usually gives way in several places, so that many discharging holes are formed, and the destructive process proceeds until a large ulcer is formed with these characters: its edge is raised, everted, rugged, prominent, and very irregular; its base is occupied by a foul, fungating mass; it is of considerable depth; and it spreads by advancement of the ulcerative action. The fungous mass represents the remains of the sebaceous contents mixed with a crowd of very exuberant granulations that spring from the lining membrane of the cyst, now irritated by the presence of too much effete matter. The sebaceous matter does not itself actually become vascularized, as some less recent authors have urged, but the persistent irritation produced by the morbid changes in the exposed cyst-wall perpetuates the ulcerative process, and leads to a spreading of the sore. Cock gives some excellent drawings of this condition.[1] This peculiar ulcerative process appears to be most apt to affect cysts of some standing, and especially those occurring in old persons, the disease being rarely met with before fifty. Considering the usual age of the patients, and the general features of the ulcer, it will be seen that this might readily be taken for epithelioma.[2] Any difficulties on this point may, however, be cleared up by noticing in the non-malignant ulcer the history of the case, the presence possibly of unaltered sebaceous matter, the absence of a hard infiltration of the periphery, as in epithelioma, the fact that the disease progresses with little bleeding and less pain, while the health remains good, and the glands are unaffected. It must be remembered, however, that such ulcers as these may take on a genuine epitheliomatous action.[3] Some of the reported cases are cases rather of fungating sarcoma of the scalp.[4] In regard to *treatment*, the surface of the ulcer having been well cleaned by a poultice, the remaining portion of the cyst may be excised. The operation is, however, often tedious and bloody, and a better plan, therefore, is to apply the actual cautery lightly, but thoroughly, to the whole remaining surface of the cyst, when a slough separates, and the ulcer generally heals kindly.

Horns.—These strange excrescences are developed from the interior of a sebaceous cyst that has been opened up, either by rupture, or, more usually, by inflammation. They have the appearance, and almost the density, of actual horn, and are formed of heaped-up sebaceous matter that has become dry and indurated. Fresh matter is constantly being formed at the base of the excrescence, and so it increases in length and bulk. Sir Erasmus Wilson has given a full account of these growths.[5] Out of 90 collected cases, 44 were in females and 39 in males, the sex of the remainder being unknown; in no less than 48 out of the 90 cases the horn grew from the head, and 38 of these scalp cases occurred in patients past middle life. The horn is generally single, somewhat pointed, and curved. In the New York Medical Repository, for 1820, is recorded the case of a man from whose forehead grew a horn that had three branches and was fourteen inches in circumference. In many of the recorded cases the horns have been four, five, six, and eight inches in length. If accidentally torn off they are apt to be re-formed. Their growth is slow, and they are only troublesome mechanically, and from an æsthetic point of view. As regards *treatment*, the mass should be removed, and every trace of the cyst or secreting surface at its base most scrupulously excised.

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[1] A few Remarks on a Peculiar Follicular Disease. Guy's Hosp. Reports, 2d s. vol. viii. p. 51. 1853.

[2] See a celebrated case of M. Chassaignac's, in Bull. de la Soc. de Chir., tomes i. et ii.

[3] See case reported by Dr. Péan, Leçons de Clinique Chirurg., p. 532. 1876.

[4] Goodhart, Follicular Disease of the Scalp. Guy's Hosp. Reports, 3d s. vol. xviii. p. 221. 1873.

[5] Transactions of the Royal Medical and Chirurgical Society, vol. xxvii. 1843.

II. Congenital Dermoid Cysts.—These, as regards their *anatomy*, closely resemble the common cyst. They have thinner and more perfect walls, as a rule, and are lined by a perfect epidermis, with, very often, small growing hairs. The contents are commonly spermaceti-like, or more oily or turbid, or even serous and clear, and generally present some fine loose hairs. Bryant reports a case in which the cyst contained "a complete ball of hair."[1] The contents are seldom offensive. These tumors have a tendency to indent or even perforate the subjacent bone. Many such cases are recorded.[2] As a rule, a round depression has been found on the bone, at the bottom of which has been a small hole leading to the cranial cavity. The precise cause and significance of this perforation are unknown.

Site.—The congenital cyst is usually found about the outer angle of the orbit, next in frequency on the front of the frontal bone, and very rarely, over the other bones of the vault. Cases are recorded of cysts imbedded deeply in or beneath the temporal muscle. These growths are (primarily at least) beneath the scalp muscle, and are, as a rule, closely adherent to the pericranium.

Progress.—These tumors grow very slowly, seldom exceeding the general rate of growth of the body. They rarely attain a greater diameter than two-thirds of an inch.[3]

As to the *diagnosis* of these round, tense, and typically cystic bodies, nothing need be said. They are compared with other congenital growths elsewhere. Two remarkable cases are reported of dermoid cysts mistaken for meningocele. Both cases occurred in female children, respectively three and eight months old. In each case the tumor was small, translucent, without pulse, and irreducible, and located close to the anterior fontanelle. In one case,[4] tapping gave exit to a clear fluid; in the other,[5] the cyst was situated over a congenital hole in the skull, and had pulsated in earlier infancy. Both tumors proved to be dermoid cysts, and to have no communication with the cranial cavity.

The *treatment* involves questions of difficulty. These cysts are often difficult to excise, especially when about the orbit. They appear superficial, and yet are found to extend often to a dangerous depth, and if any cyst wall be left behind an intractable suppuration follows. In other parts their removal may not be difficult. If a cyst about the orbit therefore is small, not increasing, and a source of no inconvenience, it may be well to let it alone. If excision is demanded for any reason, it must be performed with the utmost care and patience. It would, in most cases, be unwise to operate on those cysts that have certainly perforated the skull. Mr. Athol Johnson[1] reports a fatal case of this kind. Sir Prescott Hewett,[2] on the other hand, reports a case in which a dermoid cyst, after causing no trouble for twenty years, grew, perforated the orbital roof, and caused death. An unusual case of this kind, however, should hardly lead us to advocate an early removal in all instances.

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[1] Manual for the Practice of Surgery, 2d ed., vol. i. p. 104.

[2] Athol Johnson, Lectures on the Surgery of Childhood, p. 15. London, 1860.

[3] Sir James Paget and Mr. C. H. Moore, loc. cit., p. 514.

[4] Giraldès, Comptes rendus de la Soc. de Biologie, 4e série, tome iii. p. 77. 1866.

[5] Henry Arnott, Trans. of Path. Soc. of London, vol. xxv. p. 228. 1874.

III. SEROUS CYSTS are extremely rare. They are either (1) congenital, or (2) formed from extravasated blood, or (3) formed from a meningocele whose connection with the cranial cavity has been cut off. Those that are congenital are, as a rule, small, multi-cystic, situate in the occipital region, and located either above or beneath the aponeurosis.[3] They contain clear serum, too rich in albumen to be mistaken for cerebro-spinal fluid. Billroth gives an example of a serous cyst over the occiput as large almost as the patient's head. The subjacent bone was quite sound.

The history of the case would, in each of the three forms, greatly assist the diagnosis. The treatment of such tumors requires no special notice.

VASCULAR TUMORS OF THE SCALP.[4]—*Nævus; Telangeiectasis; Simple or Plexiform Angeioma; Cavernous Angeioma; Erectile Tumor.* The various forms or varieties of vascular growth included under these different terms are all met with on the scalp, and may be conveniently considered under the common and generic term *Nævus.* Nævi occur more frequently on the head than on any other part of the body, and, according to Heineke, arterial angeiomata may be said to belong exclusively to the head.[5] Nævi may occur anywhere on the scalp, but are most common about the anterior fontanelle, the orbit, and the temple. They are much less common about the occiput. As Virchow has pointed out, angeiomata are often located on the sites of the branchial clefts—the "tumeurs érectiles fissurales" of French authors. The undue frequency of nævi about the head may perhaps be due to the dependent posture of the head in fœtal life, and to injury inflicted during birth. The superficial or capillary nævus is more commonly met with on the head than is the deeper or venous nævus, or cavernous tumor, the latter being generally limited to the hairy part of the scalp, while the former may occur anywhere.

All these growths are, for the most part, congenital, and appear at or soon after birth. The superficial nævus is not met with at an earlier period than are the deeper growths—the subcutaneous or venous nævus, or cavernous angeioma. There is little limit in the size of these tumors; some may be enormous, and may occupy wide tracts of the head. As Chelius[6] observes, some of the largest and most rapid growths have been met with about the ear. Mr. Barwell[7] remarks that nævus over the mastoid process may "by growth in size and complexity become a cirsoid aneurism." A growing nævus under the hairy scalp causes baldness, the hairs falling out as the atrophy of the skin progresses. These tumors may extend in depth and involve the galea, the pericranium, and even the bone, which in such cases becomes porous from the number of its vessels.[8] They may, on the other hand, undergo spontaneous cure, especially after an inflammation of the soft parts. Such a cure usually occurs in the superficial, cutaneous nævi, and is much less frequent in the more deeply seated tumors, or in the cavernous angeiomata.

Diagnosis.—These blood-tumors may be conveniently divided into 1, the cutaneous; 2, the subcutaneous; 3, the mixed. 1. The cutaneous angeiomata are composed of capillary vessels arranged in an intricate plexus, and considerably altered in structure. These form the simplest kind of plexiform angeiomata, and appear as bright-red or claret spots upon the skin, their surface being commonly a little raised and granular. 2. These tumors are situated in the subcutaneous tissues, although they may extend beyond them. They are venous in structure, as a rule, the vessels being arranged in a plexus (plexiform angeioma), or after the manner of erectile tissue (cavernous angeioma, erectile tumor); they form distinct tumors, covered with purplish and thinned integument, are smooth, somewhat lobulated, doughy, and elastic, and are capable of being more or less emptied on pressure. They often increase also on violent respiratory efforts. If the tissue has much of the arterial element, the mass may feebly pulsate, but such a growth would more aptly be considered with cirsoid aneurism. 3. The mixed form is a complication of the two preceding forms, the skin being more or less involved. The tumors may ulcerate and give rise to severe hemorrhage.

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[1] Loc. cit., p. 15.

[2] Loc. cit., St. George's Hosp. Reports, p. 93.

[3] Ward, Trans. of Path. Soc. of London, vol. xi. p. 268. 1860.

[4] See Vol. III. p. 353.

[5] Loc. cit., S. 22.

[6] Chelius's Surgery, translated by South, vol. ii. p. 381.

[7] Lancet, vol. i. p. 642. 1875.

[8] Dr. Robert Lee (Med.-Chir. Trans., vol. xxii. p. 300. 1829) gives the case of a monster with extensive nævoid growth of the scalp that involved also the dura mater, the intervening bone being absent. He gives references to cases of somewhat like character.

Treatment.—If the tumor be quite stationary and small, and cause no gross disfigurement, the advisability of operation may be questioned. With regard to the many different modes of treating nævus I will say nothing, but will refer merely to those measures that appear most applicable in the scalp. Pressure with a disk of lead or a small coin, secured by an elastic band, has answered well in some small nævi that involved the tissues to no great depth.[1] It may at least be tried. With regard to operative measures, I would urge that most nævi of the scalp can be well treated either by the actual cautery or the simple ligature, with in a few cases a recourse to excision. Nævi up to the size of a shilling can, as a rule, be well treated by a light application of the thermo-cautery, if quite cutaneous, and by a more prolonged application when they extend beyond the skin. This treatment is at the time more painful than that by nitric acid (which, however, is only applicable to superficial growths), but the pain passes off much sooner, and the result is much more certain, one application being in the great majority of cases all that is required. I have used the thermo-cautery in a very large number of cases, and without a single bad result. If one has to deal with a very extensive superficial nævus, involving only the skin, the same method may be adopted, and it is then better to treat portions only of the diseased area at a time, commencing at the periphery. Large venous nævi and cavernous tumors of the width of a shilling and larger can be well treated by the simple ligature. This method is especially suited to prominent tumors covered with thin and diseased integument. I have found the following mode of using the ligature most efficacious. The mass is ligated in the usual way in two segments, a harelip pin having been passed through its base, and the threads at right angles to the pin. It is important to lightly incise the skin at the base of the growth, in the line that will be followed by the ligature. This lessens the amount of pain and the duration of the strangulating process, and in young children much diminishes the liability to convulsions. The pin is not removed. In four days the whole of the ligatured mass should be sliced off level with the surrounding skin, by passing the knife beneath the harelip pin; some bleeding follows, which is immediately checked by light pressure with cotton-wool. The advantages of this subsequent excision are these: The duration of the treatment is very greatly diminished, the risks of ill effects much lessened, and a much cleaner and finer scar is produced. If the skin over the mass be sound, ligation will hardly be so applicable, owing to the tension of the scalp; excision may then be practised, bleeding during the operation being checked by a ring of lead, or by strips of the same metal, pressed firmly against the scalp. The subcutaneous ligature appears to be peculiarly unsuited to the scalp. Nævi larger than can be treated by ligature may be excised, if all other means have failed, or treated with puncture by the actual cautery. By the latter method a fine thermo-cautery point is thrust in various directions into the substance of the nævus through the same skin puncture. Little reaction, as a rule, follows, but the mass begins to shrink. The treatment may require to be repeated five or six times in a large mass. I have found it most successful in very large nævi. Much has been said as to the treatment of nævi over the anterior fontanelle. All operative measures applied to such nævi, while the fontanelle is still open, are attended with much risk, and should never be undertaken, unless under urgent reasons, until the opening has closed.[1] The nævus, especially if deeply seated, will often much diminish in size when such closure has taken place.

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[1] See Lancet, vol. ii., 1867, article on Nævi, by Mr. Thomas Smith; and Surgical Diseases of Children, by Mr. Cooper Forster, p. 223. London, 1860.

Michaud[2] records a case of nævus of the scalp that communicated by small veins with the superior longitudinal sinus. A communication of a like character probably occurs more frequently than is at present supposed, and may account for some of the rapid deaths with brain symptoms that have followed in a few instances the treatment of even the most simple nævi in this situation.

CIRSOID ANEURISM.—*Aneurism by Anastomosis; Racemose Aneurism; Arterial Varix.*—These terms are applied to tumors made up of the dilated and varicose arteries of a given area, and their smaller branches. When the disease affects the larger arterial trunks, the name cirsoid aneurism is used, and when it extends into the capillary networks, it is known as racemose or anastomotic aneurism; the term arterial varix has been limited by some authors to the affection as it involves single large arteries.

This disease is almost limited to the head, being very rare elsewhere. It occurs usually in connection with the temporal, posterior auricular, and occipital arteries. As it increases, it may extend either towards the capillaries or towards the main trunk, and, in the latter case, may involve even the common carotid. It may extend beyond the middle line, and involve the other side of the head. The skin over the mass is usually thin and wrinkled, but may be thickened. The subjacent bone is often grooved by the dilated vessels, and Verneuil[3] gives a case in which the bone was actually perforated.

These tumors are sometimes due to injury, but more commonly arise from the dilatation of the afferent arteries of a simple angeioma, which latter growth can often be detected in the centre of the arterial swelling. They occur most usually in young adults.

Progress.—These growths are apt to increase to some extent, and may attain enormous size. They may, however, at any time become stationary, or even undergo spontaneous cure, an event that has in most cases been subsequent to a fever. The mass may ulcerate, or the skin become so thinned that rupture occurs, followed by fatal hemorrhage.

The *symptoms* of these tumors have been fully described elsewhere,[4] and it is here only needful to allude to their leading features: an irregular, varicose mass with visibly dilated arteries about its periphery, pulsation, a blowing bruit, a fine thrill felt by the fingers, reducibility of the mass on pressure, and an altered state of the integument, which is usually found thinned and discolored.

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[1] Mr. Erichsen expresses an opposite opinion; Science and Art of Surgery, vol. i. p. 717. 1872.

[2] L'Union Médicale, p. 254. 1859.

[3] Varices artérielles du Cuir chevelu. Thèse.

[4] See Vol. III., pages 354 *et seq.*

Treatment.—These vascular tumors are most difficult to cure, and are very intractable to any treatment. Should the cirsoid aneurism show no tendency to increase, give no great inconvenience to the patient, and threaten no immediate danger, it had better be let alone, being merely protected by a suitable cap or disk. With regard to operative measures, the following may be placed among those that have been tried and discarded as of little or no value: compression, ligature of the separate vessels entering the mass, and ligature of the external carotid of the same side. Ligature of the common carotid has had but indifferent success. Heineke[1] states that only three cases of cure have resulted in thirty-two instances in which this operation has been performed. [Dr. Wyeth's statistics, though not quite so unfavorable, also show that this operation should be reserved for exceptional cases.[2]] The treatment to be advised in these cases is mainly directed against the mass itself. If the cirsoid aneurism be quite small, it may be ligatured *en masse.* This has been successful, but ligature of larger tumors, and the practice of partial ligature, or ligature of successive portions, is not to be advised. Galvano-puncture also may be tried, and has been successful. It can at least do little harm. If these measures fail or be inadmissible, the best results are obtained from excision of the whole mass. This operation, to be successful, should be preceded by ligature of the common carotid artery, or by the adoption of some local means to arrest hemorrhage. This object is best attained by applying acupressure to the entire periphery of the tumor by a number of needles. After the mass has been excised, the needles should be withdrawn one by one and the separate vessels ligatured as exposed. Of all operations for the relief of cirsoid aneurism of the scalp, that of excision has certainly met with the greatest amount of success.

ANEURISM OF THE ARTERIES OF THE SCALP.—Aneurism is very rarely met with on the scalp, and in all the recorded cases appears to have been of traumatic origin. The tumor is most commonly situated on the temporal artery, though cases are also recorded of aneurism of the posterior auricular and occipital arteries. These aneurisms seldom attain a great size, few being larger than a hazel-nut, and they give, as a rule, little or no trouble. They are apt to hollow out the bone, and the skin over them may become so thinned as to lead to rupture of the sac. The tumor being very superficial, the symptoms are most characteristic. As a rule, they are readily cured. In some cases compression has effected this end,[3] and this simple treatment may at least be tried in any instance. If this fail, the artery should be ligatured on either side of the aneurism, or the "old operation" performed.

ARTERIO-VENOUS ANEURISMS are very rare on the scalp. Heineke could only find records of five cases. Of these, four concerned the temporal artery and vein, and one the posterior auricular vessels. In every instance there had been an injury. These tumors do not tend to attain great size, and they give but little trouble. If small, not increasing, and attended by no real inconvenience, they may be let alone. If for any reason an operation is demanded, the most successful consists in excising the entire mass, and ligaturing all the vessels concerned. In one case, Chelius[4] thought fit to tie the common carotid for an arterio-venous aneurism of the temple. Benefit followed, but it was only temporary.

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[1] Loc. cit., S. 30.

[2] [See Dr. Wyeth's table of 73 cases (82 operations) in Vol. III. pp. 358 *et seq.*]

[3] See case by M. Mirault, Gazette des Hôpitaux, No. 147. 1860.

[4] Op. cit., vol. ii. p. 271.

MALFORMATIONS OF THE SKULL.

These malformations are numerous, varied, and for the most part congenital. The majority of them are of no interest to the practical surgeon, and many, as, for instance, anencephaly, exencephaly, etc., are incompatible with existence. Cephalocele will be treated of hereafter. Among the acquired deformities, it is only necessary to allude to those purposely produced by certain nations[1] (such as the Caribs) by pressure upon the skull in infancy; to the "diamond-shaped head"[2] produced by compression at birth; and to the "obliquité du crâne par propulsion unilatérale"[3] induced by allowing very young infants to lie always upon the same side of the body. These are at least of some slight interest in being not quite unpreventable. Of much more interest, however, are certain *congenital holes and fissures* in the skull that appear to be of no infrequent occurrence, and to persist often throughout the life of the individual. They are all due to imperfect developments.[4] The occipital bone may present persistent fissures, the remains of those that occur in the developing bone; or a larger or smaller part of the superior angle may exist as a separate bone, the "os épactale," whose line of union with the main bone may be mistaken for a fracture. The parietal bone is frequently the seat of certain holes that may persist during life. These parietal holes are generally two in number, and are symmetrically disposed, one on either bone, at or about its most prominent point. Their usual diameter is from one-third to one millimetre. They may, however, be much larger,[5] and in the Musée du Val-de-grace, there is a skull with parietal holes that measure three centimetres. These holes may be mistaken for fractures, and are apt to seriously complicate diagnosis when a superficial growth happens to be located over one of them. Mr. Thomas Smith[6] records a case in a child aged four years, in whose skull were found the following congenital holes: one on the right side of the occipital bone, three inches by two inches, and one on either parietal, measuring respectively two inches by two inches, and two inches by one inch. Over one of these holes an abscess had formed, which pulsated synchronously with the pulse.

MENINGOCELE; ENCEPHALOCELE; HYDRENCEPHALOCELE.—These terms are applied to certain tumors that consist essentially of a protrusion of some part of the cranial contents through an aperture in the skull. They are congenital, and are observed either at or soon after birth. Reference will be made hereafter to certain rare tumors known as acquired cephaloceles. These must be kept distinct from those now under consideration. The contents of these tumors vary, and it is according to the nature of these contents that they are classified and named. When the tumor contains a protrusion of the meninges only, the term *meningocele* is used; when a protrusion of brain, the term *encephalocele;* and when the mass is formed by a portion of brain, greatly distended with fluid from a dropsical ventricle, it receives the name of *hydrencephalocele.*

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[1] For an account of such like deformities, see M. Topinard's "Anthropology."

[2] Dr. Ogier Ward, Path. Trans. London, vol. iii. p. 225.

[3] M. Guéniot, Bull. de la Soc. de Chir., tome x. p. 383. 1866.

[4] An excellent account of these mal-developments is given by M. S. Pozzi, Art. Crâne (Développement), Dict. Encyl. des Sc. Méd., p. 467. 1879.

[5] See Depressions in the Parietal Bones, by Professor Humphry, Journ. Anat. and Phys., vol. vii. p. 136. 1874.

[6] Path. Soc. Trans. London, vol. xvi. p. 224. For account of Aplasia Cranii (imperfect ossification of skull), see, also, Heineke, loc. cit., S. 43.

Anatomy.[1]—These various tumors are of a round or pyriform outline, and present as a rule a uniform surface. Sometimes, however, sharp fissures or depressions appear upon the surface, giving the mass a lobed appearance, suggestive of its division into two or more parts. In size they vary greatly: the smallest may be the size of a little nut, and the largest may exceed the dimensions of the patient's head. They usually present a distinct neck, and are often actually pedunculated. As a rule, they are covered by normal scalp, more or less deficient in hair, according to the size and tenseness of the tumor; but in other cases the integuments may be much atrophied, or red and vascular, or raw like a granulating surface, or represented solely by a scar-like tissue. The sac is composed of dura mater lined by the arachnoid, and in some cases presents irregular sacculi and partitions, although in the majority of instances its interior is perfectly smooth. The hole in the skull through which the mass protrudes, varies greatly in size and shape, and usually presents a clean and even edge. If much brain has escaped from the cranium, microcephaly will exist, although it may be somewhat modified in its conspicuousness by the hydrocephalus that is very often present in these cases. Scoliosis or unequal development of the skull is also common in severe instances; and other congenital deformities, such as spina bifida, hare-lip, cleft palate, talipes, and umbilical ruptures, not infrequently coexist.

Of these tumors, *meningocele* is the rarest. Indeed, some authors question its existence.[2] It simply consists of a protrusion of the dura mater and arachnoid, and may be regarded as a limited hydrops of the arachnoid sac. Heineke regards it as the remains of an encephalocele, the protruded portion of brain having returned into the skull. Others, however, consider meningocele as the commencement of a brain protrusion. There is no doubt that this tumor is extremely rare, and that the bulk of the cases reported as meningoceles are really hydrencephaloceles. *Encephalocele* is not so uncommon, and consists of a hernia of a portion of the brain, that is usually connected with the cerebral mass by a narrower portion or pedicle. There may be no fluid in the sac, but if any is present, it is entirely external to the brain substance. *Hydrencephalocele*, by far the gravest of these tumors, is, unfortunately, the variety most usually met with. The piece of brain protruded in these cases is found to be distended by fluid from a ventricle. Indeed, the condition is that of an extreme but limited ventricular hydrocephalus. The cavity in the protrusion is connected with the affected ventricle by a contracted channel that may be very narrow, the hernial portion being as it were a diverticulum from the ventricle. The protruded portion of brain may be so distended as to be represented by a mere film of cerebral matter, and in many cases all traces of it are lost except about the neck of the tumor. The corresponding ventricle is always distended, such distension being, however, as a rule, infinitely less in degree than that found in the protruded part. This is generally so distended that all trace of convolution on the surface is lost. In addition to the internal collection, some fluid may also be found in the sac, quite external to the brain.

Situation.—By far the most common site for these tumors is the occipital region, and next the fronto-nasal region. From the base of the skull, and from the parietal and temporal regions, these protrusions are rare. In 93 collected cases, 68 were about the occiput, 16 in the fronto-nasal region, and 9 about the base.[3]

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[1] For a full account of the anatomy of these affections, see an article by Sir Prescott Hewett, in St. George's Hospital Reports, vol. vi. p. 117. 1873. Also monograph by M. Spring, Mém. de l'Académ. de Belgique, tome iii. Brussels, 1853.

[2] L.-A. de Saint-Germain, Art. Encéphalocèle, Nouveau Dict. de Méd. et de Chirg. Pratique, p. 195. 1870.

[3] Houel, Arch. Gén. de Méd., 5e série, tome xiv. pp. 409, 569. 1859.

(1) *Occipital Region.*—The hole in the occipital bone through which the mass protrudes, is in or near the middle line, and may be above or below the protuberance. If above, it may blend with the front fontanelle, and if below, with the foramen magnum, or in addition with the cleft for a spina bifida. The tumors in this situation are apt to be large and pendulous, of pyriform shape, and pedunculated. Chauvier records a case, occurring in this locality, in which the mass hung from the back of the head to the loins.[1] In some cases the whole or the greater part of the occipital bone may be absent; or, if present, it may show a complete median cleft. Occipital encephaloceles may contain portions of the posterior cerebral lobes or of the cerebellum. A hydrencephalocele in the upper part of the bone would probably contain part of the posterior lobe or lobes of the cerebrum, and the distended posterior cornu of the lateral ventricle; in the lower part of the bone, the whole or part of the cerebellum with a dropsical fourth ventricle. In large masses, both the cerebrum and cerebellum may be concerned.

(2) *Frontal Region.*—The tumors usually appear at or about the root of the nose, the protrusion leaving the skull between the cribriform plate and the frontal bone, and appearing externally between the frontal and nasal bones. In a few cases the protrusion has been between the halves of the frontal bone,[2] and in still fewer in the lateral parts of the bone.[3] The anterior lobes are the parts of the brain involved, with, in cases of hydrencephalocele, the anterior cornua of the lateral ventricles. Tumors in this site are usually smaller than those on the occiput, and present few, if any, of those surface divisions so common in the tumors of the latter situation. The skin covering them is also very frequently red and vascular, so that these frontal tumors have often been mistaken for vascular growths. Enormous tumors have, however, been met with in this locality,[4] but they are rare when compared with the frequent occurrence of such large growths over the occiput.

Sides and Base of the Skull.—Congenital protrusions have occurred at various parts of the sides of the skull, chiefly about the lateral fontanelles or in the lines of sutures. Mr. Hutchinson[5] quotes a case occurring at the anterior fontanelle, and Dr. Steavenson[6] a median protrusion through a cleft extending from the posterior fontanelle to the alveolar process of the jaw. At the base of the skull, the hole has been found between the ethmoid and sphenoid bones, or between the sphenoid and its greater wing, or through the sphenoid itself. Tumors issuing from such apertures have appeared in the pharynx or in the mouth, have even projected beyond the mouth, have occupied the orbit and displaced the globe, or have escaped by the spheno-maxillary fissure. Hydrencephaloceles about the base have been composed of the temporo-sphenoidal lobes distended by the inferior cornua or the base of the third ventricle, or by the infundibulum and pituitary body pushed down by fluid distension occurring in the last-named ventricle.

Into the *etiology* of these affections, the limits of this article will not allow me to enter. A vast number of theories have been advanced, the most generally received being one that explains the protrusion by the existence of an intra-uterine hydrocephalus. The whole matter is well discussed by Heineke.[7]

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[1] Quoted by Sir Prescott Hewett, loc. cit., p. 119.

[2] See a case, for instance, reported by Mr. Christopher Heath. Trans. of Path. Soc. London, vol. xvi. p. 10. 1865.

[3] Case by Robt. Adams, Dublin Journ. of Med. and Chem. Science, vol. ii. 1833. Other cases are quoted.

[4] See a case reported by Niemeyer (De Hernia Cerebri Congenita. Halæ, 1833.), in which the tumor reached the clavicle.

[5] Illustrations of Clinical Surgery, vol. ii. Plate 46.

[6] Trans. Clinical Soc. Lond., April, 1881.

[7] Pitha und Billroth's Handbuch, Band iii. Chirurgische Krankheiten des Kopfes.

Symptoms and Diagnosis.—All these tumors have to a greater or less extent the following general characteristics. They are congenital, are most common over the occiput or root of the nose, and are fixed at their bases. They form roundish, elastic tumors, with, as a rule, some evidence of fluid contents; have often a pulsation synchronous with the beat of the heart;[1] are increased in size by forced expiratory efforts; and are more or less reducible, such reduction being often followed by brain symptoms (sense of pain or restlessness, vomiting, convulsions, or stupor, with, in some cases, strabismus and temporary loss of muscular power). If pendulous, the very weight of the tumor may cause such symptoms, all trouble passing off when the mass is elevated. In some cases the hole in the skull may be felt, and often the head is microcephalic, or shows unequal development. The separate symptoms of each special form of tumor, and the points in which they differ from one another, and which constitute the elements of their differential diagnosis, may be best exhibited in the form of a table.

	Size and surface.	Coverings.	Pedicle.	Fluctuation.	Translucency.	Pulsation.	Effects of forced expirations.	Reducibility.	Pressure effects.	Condition of skull, etc.
MENINGOCELE.	Small, especially at first. — Surface smooth.	As a rule normal; may be thinn'd.	As a rule pedunculated.	Most distinct.	Perfectly translucent throughout.	Rarely present	Render the tumor more tense.	Always reducible, as a rule completely.	Symptoms produced only on strong pressure.	As a rule normal.
ENCEPHALOCELE.	As a rule small, seldom exceeds size of small orange. — Surface smooth.	As a rule normal; may be unduly vascular.	Has a wide base; is rarely pedunculated.	Absent (mass soft and yielding) unless there be fluid in sac.	Opaque, unless there be fluid in sac, when mass may be translucent at apex.	Distinct pulsation.	Produce distinct enlargement.	Reducible, but not always completely.	Symptoms readily induced.	As a rule normal.
HYDRENCEPHALOCELE.	Generally large, often of great size, and pendulous. — Surface often irregularly divided or lobed.	Often thin, excoriated or wrinkled.	As a rule distinctly pedunculated.	Distinct.	Often translucent, but only at the most prominent and dependent parts.	Very seldom pulsate.	Produce only a very slight effect.	As a rule are but little affected in size by pressure, and are irreducible.	Symptoms seldom induced.	Microcephalic, or scoliosis. May be paralysis of limbs or talipes.

These tumors have been mistaken for sebaceous cysts,[2] for abscesses,[3] for vascular growths,[4] for cephalhæmatomata,[5] for serous cysts,[6] and for nasal polypi.[7] In the last instance (Dr. Lichtenberg's case), a large bluish tumor projected some way out of the mouth. Its pedicle was traced through a cleft palate up to the roof of the nose. It was ligatured. Death ensued in four days. It was then found to be a cerebral protrusion that had issued through a hole in front of the sella turcica.

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[1] Sir Prescott Hewett says that pulsation is absent in the majority of cases. Loc. cit., p. 134.

[2] Holmes's Surgical Treatment of Children's Diseases, page 67. 1868. See also Prescott Hewett, loc. cit., pp. 134.

[3] Athol Johnson, Lectures on the Surgery of Childhood, p. 11. 1860.

[4] Th. Zdzienski, Encephaloceles Congenitæ Casus rarior. Dorpati, 1857. Paul Dubois, quoted by Sir P. Hewett, loc. cit. M. Guersant, Bull. de la Soc. de Chir. de Paris, tome i. p. 66. Jon. Hutchinson, Illus. of Clin. Surgery, vol. i. page 1.

[5] Observations on Surgical Diseases of Head and Neck. (Ferrand.) Sydenham Soc., p. 125. 1848.

[6] Case of M. Chassaignac's, quoted by M. L.-A. de St. Germain. Nouveau Dict., loc. cit.; also Holmes, op. cit., p. 66.

[7] Lichtenberg, Trans. Path. Soc. Lond., vol. xviii. page 250.

Progress and Prognosis.—The majority of infants who are born alive with these deformities do not long survive their birth, but die during the first few days or sometimes weeks of life. The prognosis is worse in hydrencephalocele than in the other tumors. In hydrencephalocele, indeed, the prognosis is absolutely bad; in many cases the condition of the brain is incompatible with any but the briefest existence, and in other instances the mass rapidly enlarges, and in time bursts, death occurring from collapse or convulsions, or acute meningitis. Very few indeed live even a few weeks. Sir Prescott Hewett[1] and Laurence[2] give cases in which patients survived some months, but these instances must be regarded as quite exceptional. In meningocele the prognosis is a little better. As a rule, however, the tumor increases rapidly, bursts and causes death, and this event usually occurs soon after birth. Some increase much more slowly, and months may elapse before a rupture takes place. Others, having attained a certain size, remain stationary for an indefinite period, while in still more fortunate instances the cavity of the tumor becomes cut off from the cranial cavity, and the tumor becomes harmless.[3] Many cases therefore of cure of meningocele have been recorded. It is in encephalocele that the prognosis is the most favorable. Although a great number die soon after birth, yet the early mortality is not as great as in the other forms of tumor. In some cases there may be fluid in the sac, and this, by increasing, may cause rupture, and death from meningitis, etc. But commonly the tumors attain no great size, and very commonly remain stationary. Some patients thus affected may therefore reach puberty, but they often are idiotic, or suffer from paralysis or some other gross nerve lesion. Patients with encephalocele have, however, survived many years and enjoyed perfect health. Such cases have been met with in patients aged 15,[4] 20,[5] and 33[6] years, and between these ages no small number of cases have been recorded. As regards the situation of these congenital tumors (regarded generally), the prognosis is most unfavorable for those about the occiput, not so grave for those in the frontal region, and least serious for those upon the vertex.

Treatment.—Operation in these cases is only justifiable under *one* condition, and that is when rupture of the tumor is threatening. Otherwise the mass should be simply protected, and as firm pressure applied as the patient can bear without inconvenience.

(1) *Meningocele.*—If rupture be threatening, the sac may be emptied by the trocar, and pressure applied. If it refill, it should be tapped again, and the repeated tapping may result in cure.[7] If, however, the sac refill in a shorter time after each tapping, and the fluid become dull, injections of iodine may be used. It must be owned, however, that this latter treatment has met with no success, although in two cases[8] the tumor remained stationary after the injection. Mr. Holmes uses a solution of one part of tincture of iodine to two parts of water; he injects two drachms of this solution, and allows it to

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[1] Loc. cit., p. 132.

[2] Med.-Chir. Trans., vol. xxxix. p. 307. 1856.

[3] See cases by Mr. Solly, Med.-Chir. Trans., vol. xl. p. 19, and Mr. Hutchinson's Illust. of Clin. Surg., vol. ii. p. 25. Dr. Carrington has recorded a case of so-called meningocele that became apparently quite harmless. Lancet, vol. ii. p. 894. 1880.

[4] Prescott Hewett, loc. cit., p. 138.

[5] Robert Adams, loc. cit.

[6] Guyenot, Mémoires de l'Académie de Chirurgie, tome i. p. 863. See other cases in J. Z. Laurence's paper.

[7] Case recorded by Mr. James West; Lancet, vol. vii. p. 552. 1875.

[8] Cases recorded by Sir James Paget, Path. Trans., vol. xvi. p. 12, and by Mr. Holmes, St. George's Hosp. Reports, vol. i. p. 35. 1866.

remain. In a case where the coverings of the sac were sloughing, Mr. Annandale[1] ligatured the mass; a cure followed.

(2) *Encephalocele.*—If there be fluid in the sac, by the increase of which perforation is threatened, the case may be treated as one of meningocele, as far only as repeated tappings are concerned. If the case be one of simple encephalocele, gentle pressure should be tried in reducible cases, and protection adopted in those that are irreducible. In one case, at least, pressure has induced cure.[2]

(3) *Hydrencephalocele.*—These tumors can only be treated by protecting them from injury or undue pressure. All operations, save puncture to prevent a threatened rupture, would be impracticable. Several cases are recorded where meningoceles, and even encephaloceles, have been cut into by mistake, and a cure of the tumor resulted. Such cases should, however, be regarded rather as warnings than as examples for practice.

Diseases of the Skull, etc.

Pericranitis and Cranitis. (*Osteo-periostitis.*)—The term *pericranitis* is applied to inflammations of the pericranium, the term *cranitis* to an inflammation of the bones of the skull. From a pathological and a clinical point of view, however, it is both difficult and inadvisable to consider these two affections apart from one another. In the great majority of instances of pericranitis, the subjacent bone is already inflamed, and the mischief in the membrane is secondary to the mischief in the bone. Primary pericranitis is an affection by no means of common occurrence, and inasmuch as inflammations of the bone and of the membrane on its outer surface are so intimately associated, it is more convenient to consider them together under the title of *osteo-periostitis.*

It must be remembered that the pericranium does not hold those important relations to the bone it covers that exist between the periosteum and the bones of other parts of the body. The principal blood-supply of the skull bones is derived from the vessels supported by the dura mater. These bones are, therefore, to a great extent, independent of the support afforded by the pericranium, a fact illustrated by those cases in which little or no bone mischief has followed upon extensive separation of this outer membrane. Osteo-periostitis of the skull may be acute or chronic.

I. Acute Osteo-periostitis.—*Etiology.*—The commonest cause of this form is injury, especially a lesion that directly injures or exposes the bone, or that is associated with impacted foreign substances of any kind.

It not infrequently follows from wounds, the discharges of which have become retained or offensive. It may be due to the spreading of a like mischief from neighboring parts, from the bones of the face, orbit, or ear. In some rare cases, acute osteo-periostitis has been set up by the invasion of the bone or periosteum by a spreading ulcer of the scalp.

It has been asserted that this affection may be of purely spontaneous origin, and may be due to exposure to cold, to rheumatism, to gout, and to syphilis; but the facts brought forward in support of these assertions are, it must be confessed, somewhat meagre.

Pathology.—The pericranium becomes congested, softened, and thickened, and dissected from the subjacent bone by a varying amount of inflammatory material that has been poured out between them. The inflammatory products are apt to soon become purulent, and an acute periosteal abscess to be thus formed. The diploic tissue is congested and invaded with an inflammatory exudation that is also very apt to become purulent. At an early stage phlebitis of the diploic veins is prone to occur, and these vessels will be found blocked with thrombi, that in severe cases are breaking down in suppuration. As not infrequent complications may be noted inflammation of the dura mater or of the other membranes of the brain, collections of pus between the dura mater and the bone, thrombosis of the cerebral sinuses, and in rare instances abscess of the brain.

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[1] Edinburgh Medical Journal, April, 1867.

[2] Case recorded by M. Ferrand, loc. cit., p. 125.

The inflammatory action may extend towards the surface and result in a suppurative inflammation of the sub-aponeurotic connective tissue, or of the scalp itself. If a fatal termination does not ensue at an early date, necrosis of the affected bone is a common result of this malady.[1]

The *symptoms* of this disease are somewhat obscure, and are apt to be masked by those more serious complications with which it is so often attended. The patient complains at first of a fixed pain at some part of the skull, which pain persists, is frequently intense, and usually much worse at night. Rigors occur, associated with fever, headache, vomiting, and in some cases delirium. A painful, tense, and deep-seated tumor appears at the affected spot, if the skin be intact, and in the centre of this mass fluctuation in time becomes evident. There is often some œdema of the scalp, especially in the later stages. If the tumor be incised, pus escapes, and the subjacent bone is found to be bare. Cerebral symptoms are apt to supervene, or, if the case assume a more favorâble aspect, necrosis of the affected bone may be diagnosed. From diffuse inflammation of the scalp this malady may be distinguished by the early appearance of œdema in the former affection, the somewhat less intense character of the pain and general symptoms, and the fact that the swelling is diffuse and apt to spread widely, whereas in osteo-periostitis it remains limited to the bone involved, and does not extend beyond the lines of the sutures.

The *prognosis* is unfavorable. Death occurs in the majority of cases, being caused usually either by cerebral complications or by pyæmia. The early and marked implication of the veins of the part especially favors this latter termination. In rare instances resolution may occur. In other cases a necrosis of the inflamed bone is brought about. This necrosis may be of a slight and superficial character, but more usually it involves the entire thickness of the affected bone.

Treatment.—Cases of acute osteo-periostitis of the skull must be treated on the general principles advocated in the treatment of like conditions elsewhere. An early incision is imperative, and a free exit must be given to all purulent collections. An ice bag should be kept constantly applied to the head. If the affection can be recognized early, and its nature clearly demonstrated, it may be advisable to trephine the external table and open up the diploë. The early occurrence, however, of diploic phlebitis would negative to some extent the usefulness of this measure.

II. CHRONIC OSTEO-PERIOSTITIS may in rare instances follow upon the acute form of the disease, but in the great majority of cases is due to syphilis.

The *pathology* of this affection (considering only the more common form) is treated of in other portions of the work. In this place it is only necessary to allude to the few points that follow: The inflammatory process involved in the usual form of chronic osteo-periostitis is that known as the gummatous; and, indeed, the disease is described by some authors under the title "osteitis gummosa cranii." The gummatous change may commence either in the bone itself, in the deeper layers of the pericranium, or in the dura mater. Most usually it commences as a gummatous pericranitis. The frontal and parietal bones are those most commonly attacked, but the disease may involve many bones, and is in some cases very extensive. If the affection commence on the surface of the bone, the pericranium becomes lifted off by the material of the gumma, and an external tumor is perceptible that is known as a syphilitic node.

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[1] A good account of this affection, illustrated by excellent plates, will be found in Mr. Jonathan Hutchinson's Illustrations of Clinical Surgery, vol. i. London, 1878.

If the bone be affected, it is found to be penetrated by gummatous matter, and the parts involved often become converted into a soft lardaceous mass. This soft material may be absorbed, and in this way a loss of substance in the bone becomes obvious; and if the whole thickness of the bone has been involved, a perforation results. These defects and perforations are not filled up by new bone, but are covered in by a fibrous cicatrix derived from the fibrous investments of the bone at the affected part. Many parts of the bone may be attacked at once, and so many little pits and perforations may be formed in a comparatively small area. To this form of the malady Virchow has given the name of dry syphilitic caries. About these bone defects, osteophytic plates are apt to form upon the surface of the skull, and are derived from ossification of the inflammatory or gummatous material.

Speaking generally, the syphilitic deposit (as it is often called) may (1) be absorbed, (2) may ossify, or (3) may break down into suppuration. An example of absorption is afforded in dry syphilitic caries, and in the entire disappearance of large subpericranial nodes. Ossification is not uncommon. By its agency, the affected bone is rendered denser, thicker, and more compact. If the pericranial deposits ossify, hard, irregular elevations of bone, of variable size, may be formed, constituting one form of exostosis. In the same way, from ossification of material thrown out between the dura mater and the bone, exostoses or growths from the inner surface of the skull may be produced. The rarest mode of ending for the syphilitic material is by suppuration. Necrosis may follow from this disease, of which sequence more will be said presently.

The *symptoms* are often somewhat indefinite, and the nature of the disease can be more often suspected than positively diagnosed, especially when the morbid process is deeply seated in the bone. The patient, the subject of tertiary syphilis, complains of slight but fixed pain in some part of the head. This pain is worse at night, and is influenced not a little by the state of the weather. There will generally be some tenderness on pressure. If the pericranium be involved, a deep-seated, hard swelling very slowly forms—a syphilitic node. This swelling holds a very chronic course, and may in time disappear, or become bony, or break down into pus. If there be no surface node, the diagnosis is more difficult, and no cases are more hard to interpret than are those in which the irritation of a projecting syphilitic mass from the interior of the skull has caused brain symptoms. The amenability of the disorder to antisyphilitic treatment is of much value in the diagnosis.

The *treatment* of syphilitic osteo-periostitis of the skull does not materially differ from the treatment adopted in like bone disease elsewhere. Iodide of potassium should be freely and diligently given, and every measure adopted that may improve the patient's general health. In the majority of cases, the administration of mercury at the same time will be found of considerable advantage, unless there be something in the patient's condition to contraindicate the drug. The inflamed part should be protected, and no application is needed beyond that used for this protection. If there be certain evidence of suppuration, an early incision down to the bone will be called for. The prognosis in these cases is on the whole favorable.

Caries of the Skull.—Caries is frequently met with in the skull bones, although the structure of these bones predisposes them rather to necrosis.

Etiology.—The commonest cause of caries in this locality is undoubtedly tertiary syphilis, the disease following upon a chronic syphilitic osteo-periostitis. Many cases are due to scrofula, and in a few rare instances, the cause is injury. Caries from injury is extremely rare in the healthy, the usual degenerative change, if any, being necrosis. If caries should follow upon traumatism, it will then be usually quite limited and restricted to the external table. Some conspicuous exceptions have, however, been recorded. Sir Prescott Hewett[1] cites a case of caries of the frontal and both parietal bones, and of part of the occipital bone, that followed from a simple blow on the head. Abercrombie[2] records a remarkable case where very extensive caries of the *internal* table occurred after a by no means severe fall upon the head, and a few other exceptional cases of a like nature have been reported. Caries may also extend from the upper cervical vertebræ to the adjacent bones of the base of the skull, and Sir P. Hewett asserts that caries in this latter situation may likewise be due to extension of inflammation from extensive syphilitic ulcers of the pharynx. Caries of certain parts of the temporal bone is usually subsequent to suppurative catarrh of the tympanum.

Pathology.—Caries may attack any part of the skull, although it has a special predilection for certain localities. It is most often met with on the frontal bone, particularly at its anterior part, or about its union with the parietals. Next in order of frequency may be placed the mastoid process, and then, perhaps, the occipital bone. Although the disease is usually limited, it may be, on the other hand, very extensive, and may involve, indeed, almost the entire skull. The external table is more frequently implicated than is the internal table; or, if they are both involved, then still will the change be usually more extensive in the outer plate. Mr. Gray[3] has recorded a curious case of caries, fatal through brain complications, where the disease was limited to a small carious spot on the sella turcica. Caries may commence in either the external or internal table, or in the diploë; or it may appear simultaneously in more than one of those parts. Into an account of the minute changes in caries of the skull, it is unnecessary here to enter. Such changes are identical with those observed in caries elsewhere, and have already been fully dealt with in a previous article. Some few special points, however, require notice. Caries of the skull in the dried specimen presents the familiar aspect of caries in other parts. The diseased surface is eroded and worm-eaten, and the limits of the affected district very irregular. The depth to which the destructive action may penetrate from the surface varies greatly. It may extend only through the outer table, or may involve more or less of the diploë, or may perforate to the internal skull-plate. The carious action is usually more destructive in the diploic tissue than in either the external or internal table; the result being that some undermining of those tables about a carious hole is very common. If the disease has spread from without inwards, and caused perforation of the inner plate, the perforations are apt to be small and numerous, rather than solitary and extensive. Exceptions, however, are by no means uncommon.

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[1] Lectures on Injuries and Diseases of the Head. Med. Times and Gazette, vol. i. p. 230. 1855.

[2] Pathological and Practical Researches on Diseases of the Brain and Spinal Cord, p. 188. Edinburgh, 1845.

[3] Trans. Path. Soc. London, vol. ii. p. 19.

Caries due to *syphilis* may assume one of two aspects—dry caries (so called) and ulcerating caries. The former variety has already been alluded to in speaking of osteo-periostitis. A skull, the subject of this affection, usually exhibits over a more or less extensive surface a number of holes in the outer plate. These holes are clean cut and irregular, and vary in size from that of a mere pin's-point to that of a three-penny piece, or larger. The edges of these holes are, as a rule, very thin, and much undermined by a more extensive loss of tissue in the diploë. The internal table may be thinned and perforated in a few places. In some rare cases there is a slight formation of coarse, new bone about the carious spots, and in other instances the edges of a large hole in the external table will be found rounded off, and the diploë beneath converted into dense compact bone, that may fairly be spoken of as an osseous cicatrix. In the recent specimen, the depressions, holes, and cavities in the bone are filled in with gummatous material. In the ulcerating form of caries, suppuration has taken place, and the disease presents the aspect of ordinary caries, except for the fact that very often the mischief so spreads as to form an annular or semi-annular outline. This tendency of the edge to become rounded is identical with a like tendency in tertiary syphilitic ulcers of the skin. This form of caries usually begins with the formation of a subpericranial gumma; and in cases where the internal table is first attacked, with a gummatous deposit between the dura mater and the bone. As compared with other varieties of caries, that due to syphilis is more apt to be extensive.

In *scrofulous* or *tuberculous* caries, we have to deal with a true tubercular process in the bone. The affection commonly commences by changes in the deeper layers of the pericranium, and probably at the same time in the outer surface of the bone. The pericranium, thickened and congested, is lifted off by a collection of inflammatory material beneath it. Thus an external tumor is formed that is sometimes known as a scrofulous node, or gumma. In process of time, if this tumor be incised, a quantity of curdy, ill-conditioned pus will escape, and the subjacent bone be found carious. In like manner the mischief may commence on the inner aspect of the cranium. In some instances the disease would appear to commence in the diploë, and when so commencing it may lead to the most typical forms of what is known as *perforating tuberculosis of the skull.*

In this disease, the affected bone is found converted into a more or less cheesy material, and more or less extensively destroyed. The inner and outer tables are both perforated. At the seat of these perforations, the dura mater and pericranium will be found more or less separated from the subjacent bone by inflammatory or purulent matters. In time an external tumor forms. This, on being incised, allows of an escape of pus that has been pent up beneath the pericranium, and the nature of the affection becomes obvious.[1]

Scrofulous caries is usually of limited extent, but some few cases are recorded in which it has involved large portions of the skull. Mr. Cæsar Hawkins, for example, describes a case where the right parietal bone, the right half of the occipital, the squamous and mastoid portions of the right temporal, the great wing of the sphenoid, and a large part of the frontal, were affected with scrofulous caries on both surfaces.[2] The disease in this case was rapid and soon fatal.

Symptoms.—The course of caries is usually slow and deliberate. In *caries of the outer table*, a part of the skull becomes a little tender, and the seat perhaps of a fixed pain that is worse at night. In time, a small, hard, deeply seated tumor appears at this spot. This enlarges and softens. On being incised, pus escapes, and carious bone can be felt with the probe.

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[1] For a full account of Perforating Tuberculosis, see a paper by R. Volkmann, Centralblatt für Chirurgie, 1880, No. 1.

[2] Med.-Chir. Trans., vol. xxxix. page 285. 1856.

Caries of the inner table may give rise to the most misleading symptoms. Its certain recognition is almost impossible. There will probably be fixed headache, perhaps some tenderness of the skull over the painful part, and then possibly head symptoms of various kinds—vertigo, convulsions, partial paralysis, delirium, etc. Indeed, the symptoms of caries in this situation are rather those of the brain mischief induced by the disease. If the dura mater be much separated from the bone by pus, there will probably be symptoms of compression. In *perforating caries* the evidences are a little more precise. After a period marked by some local pain and tenderness, and possibly by some vague cerebral symptoms, a tumor forms externally, which increases, and in time fluctuates. It will then be found that this tumor may be more or less reduced by pressure, and such reduction may cause temporary brain symptoms. The size of the mass also may be affected by respiration. On incision, much pus escapes, the discharge of which is rendered more free on forced expiration. The bone being now bared, a perforation of both tables may be observed.

The *diagnosis of syphilitic caries* depends to a great extent upon the history of the case, the evidences of tertiary syphilis, and the beneficial effects of antisyphilitic remedies. *Dry syphilitic caries* may be marked by almost a total absence of symptoms. A skull showing extensive disease of this nature was exhibited by Dr. Norman Moore at the Pathological Society of London. The whole vault of the skull was affected, but during life the patient had exhibited no symptoms of bone disease of any kind; the only fact noted about the head being that at one part of the scalp there was a little "eczema."[1]

In most cases, however, there is pain in the cranial bones that increases at night, tenderness of the skull, some œdema possibly of the scalp, and in some instances slight evidences of brain disturbance. Of the other varieties of caries no especial notice is required.

Prognosis.—The progress of the disease is slow, and may last months and often years, especially when it depends upon some constitutional defect.

Death may occur from simple exhaustion, in cases of extensive caries, but, as a rule, the fatal issue depends upon some intra-cranial mischief, and less frequently upon pyæmia. The depth to which the caries extends, and the degree to which it involves the inner table, are therefore matters of more gravity as regards prognosis than is the simple extension of the disease upon the surface. The usual intra-cranial lesions are thrombosis of the sinuses of the dura mater (especially apt to occur when the diploë is involved), meningitis of the convexity, and abscess of the brain. In some cases, fatal compression may be caused by a collection of pus between the dura mater and the bone, and in several instances epilepsy has followed upon the bone disease. In caries of the mastoid and petrous bones, fatal hemorrhage has occurred from the internal carotid artery, from the internal jugular vein, and from one of the adjacent sinuses, these vessels having been opened up by an ulcerative process.

Treatment.—When the disease depends upon syphilis or struma, the appropriate constitutional remedies are required. In any case the health should be supported, and freedom, if possible, from all mental excitement advised. Collections of pus should be immediately evacuated, and free exit given to all discharges. In most cases, and in those especially in which the external plate only is involved, no operative treatment is required, it being only needful to aid repair by general measures. If the caries extend deeply into the bone, and be still spreading, a cautious use of the gouge may be advised; but in no case should either the actual cautery or liquid caustics of any kind be used. In certain cases, where pus is pent up either in the substance of the bone itself, or between the bone and the dura mater, the use of the trephine is to be recommended. In caries of the mastoid process, for example, an early application of the trephine will often relieve the most distressing symptoms and arrest the progress of the disease (for a while, at least), by the evacuation of pus situated deeply in the bone. In cases of so-called perforating tuberculosis, also, where pus is retained between the dura mater and the bone, or in the substance of the diploë, great benefit may attend the application of the trephine to the diseased area.[1] The ancient treatment of recklessly applying the trephine at many points around a carious spot is strongly to be condemned. Mr. Bryant[2] has recorded a case in which he trephined out a piece of carious bone in a patient who had become epileptic after the appearance of the disease, and who was suffering from hemiplegia. Considerable improvement followed upon the operation, but it was only temporary.

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[1] See Lancet, Feb. 5, 1881.

NECROSIS OF THE SKULL.—*Etiology.*—Necrosis may follow upon injuries of all kinds, especially upon fractures, where pieces of bone have been more or less entirely separated from the skull, and thus deprived of their blood supply. It may follow also upon simple contusions of the head, and in such cases it is probably due to some lesion of the bloodvessels nourishing the bone. There has been perhaps an extravasation of blood in the diploë, with some damage to the diploic tissue, or an extravasation has separated the dura mater from the bone, or a like separation has occurred in the pericranium. As the blood supply of the cranial bones is mainly derived from the dura mater, damage to that membrane is more effective in producing necrosis than is a corresponding lesion of the pericranium. Necrosis may also follow upon burns, or upon injuries of the parts from corrosive substances. Necrosis may terminate acute or chronic osteo-periostitis. It may be due to scrofula, and, in individuals with this diathesis, it is especially apt to occur after the eruptive fevers. But if one excepts that slight form of superficial necrosis (exfoliation) which is common after certain injuries, then certainly it is to syphilis that one must look for the most common cause of skull necrosis. According to some authors, nine-tenths of all cases of necrosis of the cranium can be ascribed to the tertiary form of this disease. Heineke[3] quotes a remarkable case of necrosis of the contiguous parts of the frontal and parietal bones and great wing of the sphenoid, that occurred in a patient aged nineteen, after typhus fever. At the autopsy, it was found that the middle meningeal artery was blocked by a thrombus.

Pathology.—The seat of necrosis varies considerably. When due to injury, it may of course be in any bone, but the idiopathic forms are especially apt to attack the frontal and parietal bones, and are rarely met with in the occipital. Great variety is also seen in the extent of the disease. The necrotic action may involve the entire thickness of the bone, or may implicate only the external or the internal table. Its most frequent seat is in the external table, whereas necrosis of the inner plate only is extremely rare. When the whole thickness of the skull bone is necrosed, the outer table will usually be found to be more extensively involved than the inner table; or, in many instances, the destruction will be found equal on the two surfaces. Cases occasionally occur in which the whole thickness of the skull is lost at one place, and one table only at another. The necrosis is usually limited in extent. When the outer table alone is involved, the disease usually takes the form of exfoliation of bone, and sometimes the pieces of bone thus separated are so small as to be almost imperceptible. This is common after scalp wounds associated with a considerable surface of bared bone. Many cases are, however, recorded of very extensive necrosis. One of the most frequently quoted cases of extensive disease is the case given by Saviard, where the whole vault of the skull became necrosed subsequent to an injury to the head. As this case is one of great importance and interest, I quote in full Saviard's account of the patient:—

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[1] R. Volkmann (loc. cit.) has performed this operation in four cases of perforating tuberculosis with good results.

[2] Medical Times and Gazette, vol. ii. page 158, 1860.

[3] Loc. cit., S. 65.

> "Une pauvre malheureuse sortit de l'Hôtel Dieu au mois d'Oct. 1688, après avoir été malade pendant plus de deux ans, en suite d'une playe à la tête qu'elle s'était faite en tombant, pour avoir bu du vin avec excès. La partie supérieure de l'os coronal, les deux pariétaux entiers et une grande portion de l'os occipital s'étant decouvert dans la suite du traitement, s'exfolièrent dans toute leur épaisseur et se separèrent en même temps: de sorte que cette exfoliation resemblait au dessus d'une tête que l'on aurait sciée et separée du reste du crâne. L'on voïoit, à l'endroit d'où ces os étaient sortés, le battement de la dure-mère qui n'était couvert que d'une pellicule fort amince."[1]

Norris[2] gives a case in which considerable portions of the parietal and temporal bones were lost, together with a great part of the frontal and occipital bones. The disease followed upon a fall on the head. A somewhat similar case is recorded by Drummond,[3] where an equally extensive necrosis followed upon a scalp wound. South[4] describes the case of a woman, who, in nine years, lost the greater part of both parietals, and some parts of the temporal, parietal, and occipital bones, from a necrosis that was supposed to be of syphilitic origin.

The mode of separation of the sequestrum is the same as that observed in necrosis elsewhere, and indeed the only pathological feature special to skull necrosis is the absence of any new bone formation. There is no invagination of the dead piece of bone, and no fresh osseous production formed to fill up the deficiency caused by its removal. If the external table alone separates, granulations spring up from the exposed, subjacent bone; these form a fibrous tissue which—with assistance from the pericranium—fills up the defect on the surface. If the whole thickness of a skull bone be involved in the sequestrum, granulations spring up from the adjacent bone, from the pericranium, and from the dura mater, and together form a mass of fibrous tissue that more or less perfectly fills up the void. The rough edges about the gap become rounded off and shelving, but beyond this show no reparative changes. In some cases of syphilitic disease, however, a slight amount of new bone may be formed around the sequestrum, so as to retain it as a watch-glass is retained, or, in the absence of such a definite formation, feeble growths of porous bone may be sometimes observed on the outer table in the vicinity of the necrosis, and such deposits often assume an annular outline.[5] It is important to note that necrosis is not limited by sutures, and, indeed, often involves the contiguous parts of two or more bones at the same time.

In the matter of *symptoms* and *diagnosis*, nothing need be added to the information given elsewhere. As may be supposed, special symptoms may arise, due to implication of neighboring nerve-structures. Sir James Paget, for example, has recorded a remarkable case of great atrophy of the right half of the tongue consequent upon necrosis of the occiput after injury. The mischief had evidently implicated the hypoglossal nerve in its passage through the diseased bone. On the removal of the sequestrum, the tongue rapidly regained its normal condition.[1]

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[1] Recueil d'Observ. Chirurg., p. 836. 1762.

[2] Trans. Med. Soc. Lond., vol. i. p. 168. 1810. Skull in Museum of Royal College of Surgeons.

[3] Med.-Chir. Trans., vol. xxxiv. p. 103. 1851. A wax model of the patient's head is preserved at the Hadlar Hospital, at Portsmouth.

[4] Chelius's Surgery, ed. by South, vol. i. p. 699. 1847.

[5] Cornil et Ranvier, Manuel d'Histologie Pathologique, p. 405. 1881.

Prognosis.—In slight necrosis involving only the external table, a cure, as a rule, results after no very protracted period. When the disease, however, is more extensive, and when the whole thickness of the bone is involved, the course may be very chronic, and often extends over months and years. Some of the most severe cases have ended in cure without a bad symptom, but as long as the sequestrum remains unseparated there is considerable risk to the patient. Death may occur from exhaustion, as in Norris's case quoted above, but more usually it is due to meningitis, or to suppurative thrombosis of some of the cranial sinuses, or to compression of the brain by pus between the dura mater and the bone, or to pyæmic infection. The probability of cerebral mischief in any case is difficult to estimate. It is most common after necrosis in the mastoid process, and least common after like mischief in the frontal region. It has occurred in cases of most insignificant bone-disease on the one hand, and has been absent in cases where the dura mater has been freely exposed to a considerable extent. Speaking without the guidance of any actual statistics, cerebral troubles would appear to be more frequent after syphilitic necrosis than after the traumatic form of the disease.

Treatment.—Collections of pus should be immediately evacuated, and free exit given to all discharges. Superficial necrosis of the outer table may be practically left to itself, or the process of exfoliation may be aided by a cautious application of sulphuric acid. Loose sequestra should be removed as soon as possible, and, if the necrosed piece be too large for convenient removal through reasonable incisions, it may be so trephined as to allow of its being extracted in segments. Trephining also may be resorted to in those rare cases in which compression of the brain is being caused by a collection of pus between the dura mater and the bone. After the removal of the sequestrum, every precaution should be taken to protect the part from injury, while, at the same time, the wound is kept scrupulously clean.

The knowledge that the dura mater is exposed in any case, would appear to me an argument in favor of early removal of the sequestrum, rather than an excuse for leaving it in situ for a while, as some have vaguely advised.

Hypertrophy of the Skull.—Under the simple term "hypertrophy," or the vaguer title "hyperostosis cranii," several distinct and different forms of morbid change in the cranial bones have been described. It is no matter of surprise, therefore, that this subject has been involved in considerable confusion. Under the above title, we may, I think, recognize at least *four* different forms of bone change. I do not maintain that these various forms represent of necessity different pathological processes: That may or may not be the case. I would only point out that a casual collection of so-called "hypertrophied skulls" would (if numerically large enough) present such distinct and constant varieties as to enable us to classify them under the four following heads: 1. Simple hypertrophy, general or local. 2. General "concentric hyperostosis." 3. "Osteo-porosis" in its various forms, the "diffuse excentric hyperostosis" of some authors. 4. "Leontiasis ossium," or "limited excentric hyperostosis." This medley of terms is the natural result of grouping different morbid appearances under a common head. I will now deal with these four aspects of disease in detail.

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[1] Trans. of Clinical Soc., vol. ii. p. 238.

1. Under this heading are classed *simple hypertrophies*, using that term in its purest sense. Of general, true hypertrophy of the skull, I know only one example. It is in the Museum of the Royal College of Surgeons. This skull is hypertrophied in every part. In structure the bones appear quite normal; the hypertrophy is uniform and accurately symmetrical, every bone and every point of a bone being in all parts evenly increased in size; the base is as much affected as the vault; all parts, therefore, of the cranium, bear to one another their normal relations, and, indeed, the only feature is pathological exaggeration. Of the cause of this condition nothing is known. It is a true hypertrophy of normal bone. Examples of local, true hypertrophy are common enough. The enlargement of certain parts of the skull, especially of the frontal bones, consequent upon atrophy of the brain, may be placed under this head.[1] In some of these cases, the increase in thickness of the bone appears to be mainly effected by the inner table. In other instances—which can hardly be called true hypertrophies—there is a deposit of new bone upon the internal plate, thus causing much thickening. The instances of thickening of the skull bones after the subsidence of hydrocephalus are also, as a rule, instances of this last-mentioned condition.

2. In so-called *general concentric hyperostosis* there is no alteration in the form of the skull, and no increase in the thickness of the component bones. There is, however, a great condensation of bone tissue, so that the diploë becomes as compact as the tables that inclose it, and the skull on section presents an uniform, ivory-like aspect. The sutures are generally obliterated. Thus are formed those compact, heavy skulls, of which specimens exist in most pathological museums. The change is usually limited to the vault, but is then evenly distributed over its entire area. It is most common in advanced life. Of its cause, nothing is known, and its recognition is impossible during life. This condition of the bone is often ascribed to a blow, or to syphilis, but I am aware of no evidence to support such suggestions. Chronic cranitis often causes a *limited* condensation of the diploë, but in such cases the adjacent bone-tissue shows evidence of inflammation, and it is hardly possible to conceive a cranitis that would evenly and precisely involve every part of the vault, and yet cause no symptoms, and be associated with no changes on the surface of either of the skull-plates.

3. The term *osteo-porosis* has been applied to the condition found in certain large, thick skulls with obliterated sutures, the bones of which on section appear uniform, and finely porous, and, to use a comparison of Sir James Paget's, very like white brick. The general shape of the skull is, as a rule, not altered, but the thickness of the component bones may be extreme, and represent four or five times the normal width on section. In the Musée Dupuytren is a skull, for example, four centimetres in thickness. Both the surfaces of the bones are generally smooth, but the vascular channels on the inner table are greatly increased in depth. The change is, more or less, entirely limited to the vault, although, in some cases, the base may be implicated. This condition of skull, known by some as diffuse excentric hyperostosis, is the outcome of several different diseases, among which may be placed, with some certainty, (1) osteitis deformans; (2) osteomalacia; and (3) a peculiar form of rickets (?), occurring in animals.

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[1] See cases in Med.-Chir. Trans., vol. xix. p. 367. 1833; also in article "Cerveau," by M. Potain, Dict. Encyclop., p. 294. Paris, 1873. In November, 1881, Mr. Pearce Gould exhibited at the Path. Soc. of London, the occipital bone from a patient with congenital absence of one lobe of the cerebellum. The bone showed a true hypertrophy at the part corresponding to the absent lobe.

(1) One of the most conspicuous features in osteitis deformans is this change in the skull, and there is no doubt that several specimens in museums ascribed to syphilis, to the effects of blows, and to compensatory hypertrophy after wasting of the brain, are examples really of this remarkable disease.[1]

(2) In cases of cranio-malacia the skull-bones become greatly and evenly thickened, the sutures are obliterated, and the texture of the bone is light, spongy, and very brittle.[2]

(3) In the museum of the Royal College of Surgeons are several skulls of young lions and monkeys, that have died in confinement of a disease resembling rickets in man, and that without doubt depended upon improper diet. In these skulls, the entire vault is evenly and greatly thickened, the sutures are obliterated, and the base is not involved. The bone is very uniform on section, and is very finely porous. What is the exact nature of the affection it is impossible to say; and, indeed, the whole pathology of so-called osteoporosis of the skull is in a condition of extreme obscurity.

4. In the condition known as *limited eccentric hyperostosis*, the skull is thickened and deformed by the growth of irregular bossy masses of rough and porous bone. These masses appear to be deposited upon the outer, or sometimes upon the inner, table of the skull, but an examination of the bone in section shows that its whole structure is involved in the disease. The disease spreads; the bones of the face and lower jaw are involved. The malar bones are especially apt to be affected, and may be converted into bossy masses as large as oranges. As regards the skull, the frontal and parietal bones are those most severely involved, while the occipital bone is, as a rule, but slightly affected, and may remain absolutely exempt from the disease. The deformity produced by the disease is extreme and horrible; the cavities of the skull, nose, orbit, and mouth are encroached upon. The cranial foramina are narrowed, and may even become closed. Paralysis of the nerves at the base of the skull is therefore not uncommon, and the patient usually dies, simply worn out by the effects of the disease. The morbid change is usually very symmetrical. The bone is very vascular, and is rendered porous by the entrance of many bloodvessels. Virchow considered this disease to be akin to elephantiasis of the soft parts, and gave to it the name of leontiasis ossium. It occurs most usually in the young, appearing at or before puberty, and lasts for years. In a very fully reported case, recorded by Dr. Murchison, the disease had existed for twenty years.[3] It is commonly attended by more or less continuous headache, by neuralgia, spasms, or limited palsies. Like the other forms of skull hypertrophy, it is unaffected by any treatment.

ATROPHY OF THE SKULL.—Atrophy of the skull, or *analosis cranii*, appears under various forms. Considered generally, it is an affection of old age, being quite rare before the age of 50. It would appear to be most common in the female sex, for out of 28 cases mentioned by M. Gayraud,[4] the patients in 22 instances were women.

This subject has been very fully investigated by M. Sauvage,[5] who asserts that he met with twenty-eight cases of atrophy in examining two thousand adult skulls. This proportion, however, is probably too high.

The condition and extent of the atrophied parts vary considerably. In some cases, the bone loses its volume by progressive wasting of the diploë and approximation of the two cranial tables. These tables at last meet in one compact layer, and, by becoming themselves still further thinned, may, in time, exhibit actual perforations in parts. This condition may be general, or it may involve parts only. Parts of the skull, naturally thin, show this change most conspicuously, as for example, the lower part of the occiput, the squamous portion of the temporal bone, and the orbital roof. In other cases the absorption appears rather to take place centrifugally from one or more points, and may then commence in either of the two tables, or in the diploë. Most usually it commences in the outer plate. The entire skull may be thus involved, and a severe example of one phase of this condition is afforded in osteo-malacia.

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[1] See Sir James Paget's paper, Med.-Chir. Trans., vol. xlii. p. 37. 1877; also case reported by author in Trans. Path. Soc., 1881.

[2] A good specimen will be found in the Museum of the Royal College of Surgeons (Mr. Solly's case).

[3] Trans. Path. Soc., vol. xvii. p. 243. 1866.

[4] Dict. Encyclop. des Sciences Méd., Art. Crâne. Paris, 1879.

[5] Recherches sur l'État sénile du Crâne. Paris, 1869.

One of the most peculiar forms of the present affection is a limited atrophy of a part of both parietal bones, whereby very distinctive depressions are produced on the outer aspects of the bones. These "parietal depressions" are met with in the skulls of the aged, and are symmetrical, although they are usually more marked on the right side. The depression is oval, is situate over the parietal eminence, and has its long axis placed obliquely, so that it is directed from the posterior and upper part of the bone, forwards, and a little outwards or downwards. The depression may occupy the greater part of the antero-posterior diameter of the bone. The depression is at the expense of the outer table and the diploë. The inner table will be found unaltered in position, and the cranial cavity, therefore, is no way encroached upon.[1] In some cases, however, the disease may go on to perforation.[2] The causes of this remarkable affection are unknown.[3] There is on record a case of symmetrical atrophy of the frontal bone on either side of the middle line, and several cases of like atrophy of the occipital bone.

Atrophy of the skull is attended by no special *symptoms*, cannot be *diagnosed*, and, even if recognized during life, would probably be unaffected by any *treatment*.

CRANIOTABES AND THE CHANGES IN THE SKULL IN HEREDITARY SYPHILIS.—The term *craniotabes* is applied to two morbid conditions met with in the crania of young infants, that differ, however, only in degree. They are (1) a limited thinning of the skull bones, and (2) perforations in those bones due to extreme degrees of that thinness. Elsaesser,[4] who first described the affection, considered it to be due to rickets, but at the present time, owing mainly to the researches of M. Parrot, Dr. Barlow, and Dr. Lees, the condition is considered to be a manifestation of hereditary syphilis. The conclusions of the two last-named observers upon this point are thus expressed: "We have found craniotabes (1) not common in pure rickets, (2) not at all special to rickets, (3) very common in congenital syphilis."[5] The changes in the skull in syphilitic infants present themselves under three aspects: 1. Gelatiniform atrophy (Parrot[6]); 2. Craniotabes; 3. Osteophytic formations. These changes occur in varying degrees and at somewhat varying periods, and it is important also to observe that these changes do not occur in the crania of *all* syphilitic infants.

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[1] An excellent description of these depressions is given by Professor Humphry. Journ. Anat. and Phys., vol. vii. p. 136. 1874.

[2] Larrey, Bull. de la Soc. de Chirurg., tome vii. p. 30. 1867.

[3] The subject of causation is well discussed by M. Pozzi. Dict. Encyc. des Sc. Méd., Art. Crâne (Développement), p. 497.

[4] Der weiche Hinterkopf. Ein Beitrag zur Physiol. und Pathol. der ersten Kindheit. Stuttgart und Tübingen, 1843.

[5] Trans. Path. Soc. Lond., vol. xxx. p. 333. 1879.

[6] Ibid., p. 339.

1. *Gelatiniform atrophy* is very rare, and is met with only in very young infants, so that M. Parrot suggests that it may commence during intra-uterine life. The bones affected waste and assume a somewhat gelatinous aspect, being soft and watery; the surface of the affected portions looks eroded when the specimen is fresh. The change always commences at the surface, beneath the periosteum, and is very seldom of any depth, although M. Parrot mentions a case in which it produced perforation. It may be circumscribed or diffuse, and may involve any or all of the cranial bones.

2. *Craniotabes* appears mainly about the lambdoid suture, affecting the upper part of the occipital bone and the posterior border of the parietal bones. It consists of a great thinning of the bone, which thinning is mainly at the expense of the inner surface, so that when holes are formed, they cannot well be felt in the fresh specimen by passing the finger very lightly over the external surface of the bone. The thinned bone yields to the finger like parchment, and this parchment condition has been observed in the lower part of the occipital bone, and also in the squamous bone. The holes are generally small, about the size of a bean, and are filled in by a thin membrane. These changes occur mainly from the third to the sixth month, and occupy a period somewhat antecedent to that of the osteophytes.

3. The *osteophytic* formations consist of certain local thickenings of the skull. These appear as lens-shaped elevations on the exterior of the bone, and may increase considerably in size. Their most constant position is about the anterior fontanelle. Here bosses form on the four bones that form the fontanelle, and give rise to a remarkable elevation, traversed by depressions arranged in a crucial manner, and marking the situations of the coronal, sagittal, and interfrontal sutures at the point where these sutures meet. The anterior fontanelle, therefore, appears to be at the bottom of a hollow formed by the heaping up of the adjacent bones. Sometimes only two bosses exist instead of four. These changes appear first on the frontal bones, and then on the parietals; the occipital bone may also be affected, but not primarily. The elevations are composed of a very porous bone formation, and are of a red, violet, or maroon color; they involve the exterior of the skull only, the corresponding part of the inner table being unaltered. The thickening tends to extend from the fontanelle along the sutures first, and ultimately over the general surface of the bones. The centres of ossification are the points last attacked, so that the frontal and parietal eminences are very seldom the seat of these bone thickenings. By an extension of the enlargement, the whole skull may become much thickened, the sutures obliterated, and the development of the brain considerably hampered. These osteophytes appear to be formed from the deeper layer of the periosteum, and present the structure of very imperfect bone. Dr. Barlow considers them to be due to a hyperostosis depending upon altered nutrition, and not to be of the nature of periostitis. They appear in older children than those affected with atrophy, so that the two conditions never coexist. Craniotabes and osteophytic growth are, however, often met with on the same skull, but on quite opposite parts, the osteophytes being on that part of the skull which is most elevated in dorsal decubitus, the craniotabes on those parts which are the most dependent. It is usual, therefore, to ascribe the latter condition to pressure. Taken as a whole, all these changes appear early, certainly within the first two years of life, and usually well within the first year.

Diagnosis.—The condition of gelatiniform atrophy cannot be diagnosed during life. (Parrot.) Craniotabes is easily recognized by the parchment-like reaction of the bone under pressure, and by the presence of the holes. The latter are, however, much less easily recognized than is the former condition. The osteophytic condition can be recognized during life, if the enlargement is in any way pronounced, and so peculiar often is the general outline of the deformity about the anterior fontanelle, that M. Parrot speaks of it as the "natiform" deformity. The general condition of the infants who are the subjects of these skull changes needs no mention in this place, nor does the *treatment* of the constitutional malady. The only local treatment to be advised is to keep the back of the head free from pressure, and this is easily effected by the use of a ring of cotton-wool, or some such simple contrivance.

TUMORS OF THE SKULL.

CYSTS OF THE SKULL.—Some few cases have been recorded of cysts developed within the substance of the cranial bones. It is probable that in every instance these were hydatid cysts. Four examples of cyst have been cited by Bruns; of these, three were located on the vault, and one on the base of the skull. One of the best recorded cases of this affection is that detailed by Robert Keate.[1] A female, aged 18, presented a large tumor on the frontal bone, that occupied nearly the whole of the left half of the bone, and extended some way across the right half. It had been growing slowly for six years. The patient complained of headache, vertigo, sickness, and noises in the ears. On attempting to remove the tumor, which was of bony hardness, it was found to be composed of a cyst in the substance of the bone, lined by a membrane. A clear fluid escaped from it. The cyst had evidently developed in the diploë and had separated the two tables, the inner plate being depressed towards the cranial cavity. The contents having been evacuated, the wound was allowed to heal. The cyst re-formed, and, on being re-opened, many small cysts were found embedded in the wall of the original cyst. Attempts were made to destroy the growth with caustics, and ultimately, after an application of the saw and much exfoliation of bone, the wound healed, and a complete cure resulted. No microscopic examination was made of the cyst-contents, but there can be little doubt that the growth was due to the hydatid parasite. In a case recorded by Holscher,[2] a hydatid cyst appears to have developed from the dura mater beneath the parietal bone, and to have perforated that bone and so formed an external tumor. This tumor was soft and fluctuating, with a distinct rim of bone at its base. It suppurated, and on incision a number of hydatids were evacuated. The patient, a lad aged 14, did remarkably well. Clémenceau gives a case of spontaneous cure of a hydatid cyst of the brain, brought about by its opening externally.

SARCOMA OF THE SKULL.—Sarcomatous growths from the cranial bones are not very uncommon, and probably most of the cases of cancer of the skull, described by older authors, were of this nature.

The tumors may grow either from the surface of the skull (pericranial sarcoma) or may commence in the diploë (diploic sarcoma).

In the *pericranial* form, a tumor rapidly develops beneath the pericranium, and separates it more or less extensively from the subjacent bone. The sarcomatous growth soon penetrates into the osseous tissue at its base, diving in at many points so that the bone becomes riddled with the new material. Fine bony trabeculæ form early on the substance of these tumors. The trabeculæ radiate from the base of the growth, and serve to support the softer parts. The amount and density of this trabecular tissue vary greatly. As the mass extends externally, it forms a large, rounded, or lobulated mass, very distinctly outlined. The growth at the same time spreads more deeply into the substance of the bone; ultimately, perhaps, penetrates the inner cranial plate; and extends then between the bone and the dura mater. The sarcoma generally spreads evenly over the dura mater, forming a flattened rather than a rounded elevation of that membrane towards the cranial cavity. In time, also, the dura mater itself may become invaded by the growth.

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[1] Med.-Chir. Trans., vol. x. p. 279. 1819.

[2] Heineke, loc. cit., p. 78.

In the *diploic* form, a very similar course is observed. The mass commences in the diploë, and slowly separates and expands the cranial plates. The growth naturally tends towards the external surface as the direction of least resistance. The outer table becomes expanded and thinned, until it forms a mere cap of bone over the now fair-sized swelling. In time this bony cap gives way, and the growth appears immediately beneath the soft tissues of the pericranium and scalp. Some displacement and expansion of the inner skull-plate may be observed, but it is not common in any but a trifling degree.

Sarcomata of the cranium may be primary or secondary. Most often they are secondary to like tumors elsewhere. They are usually multiple, seldom affect the corresponding glands, and, when primary, are very apt to lead to metastases in various parts. They are most common in youth and middle life. Some few cases are recorded in quite young children,[1] and Mr. Birkett[2] has described a case of myeloid sarcoma of the frontal bone in an infant aged two months. The patient lived nine months after the appearance of the growth. Mr. Butlin[3] observes that these sarcomata in young children are usually of the round-celled variety, that they are nearly always multiple, and that they kill by metastatic formations.

Microscopically, these tumors are usually of the spindle-celled variety, especially such as grow beneath the pericranium. The more rapidly growing tumors are, as a rule, examples of round-celled sarcoma, and in any variety a certain proportion of myeloid cells is usually to be found.

Symptoms, etc.—These growths first appear as small, flat, rounded masses, which are deeply placed and very fixed. Their appearance may be preceded by headache and local pain, and these symptoms are more apt to occur in connection with tumors growing from the diploë. These growths are at first of bony hardness, and may well be mistaken for exostoses. In the case of the diploic tumor, the covering of the growth is actually of bone; in the case of the more superficial growths, there is a covering of tense pericranium. The mass enlarges rapidly, and becomes softer; if it has expanded the bone, egg-shell crackling will be detected at some period. At last, a roundish, tuberous tumor is developed, that feels soft, and perhaps in places almost fluctuating. The skin becomes gradually thinned over the mass, the hair falls off, and in time the sarcomatous material protrudes through the integuments. Often around the edge of the tumor, at its base, a raised rim of bone can be detected, and perhaps portions of the long trabeculæ may be felt in the substance of the mass. The growths, as already observed, are apt to be multiple, and to be associated with metastatic deposits. They may attain great size, especially if they occur in parts where facilities are offered for extension. Mr. Toynbee[4] records the case of a female, aged nineteen, from whose occipital bone grew a mass that in three years' time occupied the greater part of the neck on one side. It would appear from the accounts given to have been a spindle-celled sarcoma. Mr. Stanley[5] also records a case in which an enormous tumor developed from the vertex in a lad, aged fifteen. It looked like "an additional cranium growing from the vault of the skull." The patient died with brain symptoms three years from the first appearance of the disease. At the autopsy, the mass was found to have penetrated the bone, and to have spread out over the inner surface of the skull. There is little doubt, from the account given of the microscopic appearances, that this was also a spindle-celled sarcoma. In cases where the growth has invaded the interior of the cranium, various brain symptoms may be produced, such as vertigo, vomiting, severe headache, convulsions, paralysis, etc.

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[1] See case occurring in a child aged four. Path. Soc. Trans. 1879.

[2] Path. Soc. Trans., vol. ii. p. 232. 1859.

[3] Report of Proceedings of Path. Soc., Lancet, Nov. 1879.

[4] Path. Soc. Trans., vol. ii. p. 243.

[5] Ibid., vol. iii. p. 415.

The *prognosis* is bad in all cases. Death may occur from exhaustion, or may be consequent upon the suppuration and breaking down of the growth; or from this condition pyemia may ensue, associated probably with thrombosis of the sinuses. In most cases, however, death is due either to brain complications or to the development of metastatic masses in distant parts. The patient may survive for many years. Dr. Ogle[1] records a case of what was no doubt sarcoma of the skull that had perforated both tables, where the patient lived for sixteen years after the first appearance of the tumor. He died of gangrene of the lung, but during a greater part of the sixteen years had been troubled with epileptic attacks and other evidences of brain disturbance.

In the matter of *treatment*, little or nothing can be done. It is needless to observe that the practice adopted some years ago of recklessly trephining out portions of the morbid tissue, is worse than useless. Heineke[2] advises that in quite recent cases, when the tumor is small, and especially when it is of periosteal origin, an attempt should be made to remove the mass by cutting away successive portions of the skull with a chisel. In this way he suggests that the morbid tissue may be quite removed, together with some of the adjacent healthy bone. But, in actual fact, the nature of these tumors is seldom recognized until they have reached a fair size, and have involved an extent of the skullcap not anticipated by Heineke's operation. Moreover, they are very often multiple. It thus happens that in the majority of cases no operation is to be advised.

CARCINOMA OF THE SKULL.—Carcinoma of the cranial bones is always secondary. (Heineke.) It is very certain that the majority of the cases of skull cancer recorded by the older authors, were cases of rapidly growing sarcomata. The form of carcinoma that would involve these bones is the encephaloid, and it would appear that the growth seldom attains such dimensions as to form a manifest tumor. Should it form a distinct tumor, the course and symptoms would resemble those already detailed as pertaining to the sarcomata. The progress of the disease, however, would be more rapid, and it would prove fatal at an earlier period.

ANGEIOMA OF THE SKULL.—Angeiomata of the scalp may, by a process of extension, involve the subjacent cranial bones. Apart from this mode of origin, however, angeiomata may arise independently from these bones, and constitute distinct affections. They may have their origin from the surface of the bone, but more often would appear to be developed in the substance of the diploë. The affected bone becomes invaded with the vascular growth, and when that growth has origin in the diploë, the cranial plates may become more or less expanded, and replaced by the morbid tissue. The bones most often affected are the frontal and parietal. At the seat of disease, the osseous tissue is seen to be occupied by irregular, cavernous spaces, supplied by a vast number of dilated vessels.[3] The mischief is seldom of great extent, although Virchow records the case of an old woman, one of whose parietal bones was almost entirely transformed into a cavernous erectile tumor. If the mass is very large, pulsation of a feeble character may be evident. It would appear that these angeiomata, as a rule, cause no trouble, and therefore require no active treatment. It will be obvious that any operative procedures directed against a vascular growth, large enough to cause trouble, would be associated with insurmountable difficulties and dangers if directed against the part itself. On the other hand, it is doubtful if carotid ligature would affect the progress of the growth with any great certainty.

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[1] British and Foreign Med.-Chir. Rev., vol. xxxv. p. 498. 1865.

[2] Loc. cit., S. 83.

[3] See Fig. 531, Vol. III., page 369, taken from Erichsen, to show an aneurism by anastomosis of one of the parietal bones.

EXOSTOSES.—Bony tumors of the skull may be divided into three classes, according to their situation or point of origin. Those that grow from the outer table are termed *exostoses*, those from the inner *enostoses*, and those that spring from the diploë of the bone receive the name of *parenchymatous exostoses*. Considered with reference to their structure, these growths may again be divided into *ivory* tumors, *compact* tumors, and *cancellous* or *spongy* tumors. The ivory tumor is by far the most common of these, being, indeed, almost limited to the bones of the head and face; and, on the other hand, if one regards the situation of the mass, the most common growth will be that classed with the exostoses.

The *causes* of these tumors are but little known; some appear to be real new growths, others to be but partial hypertrophies of existing bone-tissue, and very many to be of inflammatory origin. Often, therefore, no cause can be ascribed to explain the production of these tumors. The symmetry which they at times exhibit, and the great number of growths that one skull may present, would suggest some very general cause in some instances. Follin and Duplay[1] quote from Hauff, the case of a woman in whom each succeeding pregnancy increased the size of a bony growth; and the same authors also mention prolonged exanthems of the scalp as a cause of at least one form of this malady. The osteomata of inflammatory origin are, however, easily explained. The great bulk of them are due to tertiary syphilis—to an osteo-periostitis occurring in that affection—while others can be traced to an injury, a blow or a fracture, followed by some inflammatory change in the part.

The *structure* of these masses is simple. The *ivory* osteoma is, as a rule, made up of concentric bone lamellæ arranged parallel to the surface of the tumor, while among the lamellæ bone-corpuscles are found, whose canaliculi radiate towards the periphery, as they do in tooth cement. The growth is non-vascular. It has to the naked eye the appearance of ivory, and its white or yellowish-white color readily distinguishes it from the adjacent bone, so that, by these means, an ivory exostosis the size of a pin's head can be easily detected.[2] The *spongy* tumors have a structure like that of the cancellous tissue or medulla of bone, and are provided with a thin covering of compact tissue. The *compact* osteoma is intermediate between these two varieties. Its tissue is like that of the compact tissue of long bones. On section it appears porous, and its lamellæ are, as a rule, concentrically arranged around vascular canals. Its color is so like that of the adjacent bone, that it forms tumors much less conspicuous to the eye, when small, than are the ivory osteomata.

On microscopic section, these bone tumors are readily distinguished from the ancient bone, owing to the fact that the Haversian canals in the growths are nearly always arranged perpendicularly or obliquely to those of the original tissue.[3] In every instance, the adjacent pericranium is continued over the surface of the exostosis.

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[1] Traité de Path. Ext., tome iii. p. 577.

[2] Hewett, Exostoses of Skull. St. George's Hosp. Reports, vol. iv. p. 3. 1869.

[3] Cornil et Ranvier, Man. d'Histologie Path., tome i. p. 267. 1881.

Connection.—The parenchymatous growth may assume the form of a distinct or an ill-defined conversion of the diploë into a compact or ivory mass. Usually, however, a tumor is formed which may project externally, internally, or in both directions. Sometimes the connections of exostoses, especially of the larger masses, to the skull, appear to be very slender, a slight degree of force separating the tumor, and separation, indeed, in rare instances, occurring spontaneously.[1] As a rule, the inner or outer table, as the case may be, of the affected spot, is lost in the tumor, but in the Musée Dupuytren is a skull with a cancellous enostosis, beneath which the inner table is to be traced, distinct and unaltered, between the tumor and the rest of the skull. Sir Prescott Hewett states that he has seen similar cases.[2] Some cranial osteomata may grow from the sinuses of the skull, mostly from those in the frontal bone, but also from the ethmoidal and sphenoidal sinuses. Much has been written as to the origin of bony growths in these parts, but still nothing certain is known as to their anatomical parentage. Certain it is that they form some of the very densest, largest, and most irregular exostoses of the skull; that they may cause terrible deformity; and that, at the same time, they often possess a singularly frail connection with the main bone. The bone in the vicinity of cranial osteomata may be normal, but it is often unduly porous, and is sometimes thickened. If an exostosis involves a suture, it usually solders the two connected bones together at the spot affected; but Hewett[3] records a case in which a suture was continuous through the middle of an ivory exostosis, so that when the skull was disarticulated the mass appeared in halves.

Seat.—Most exostoses grow from the vault, and most commonly from the frontal bone; next in frequency must be mentioned the mastoid process, and lastly, the occipital bone. As before observed, the tumors are often symmetrical. A few osteomata have been met with on the base of the skull, and allusion has already been made to those which spring from the sinuses.

Number, Shape, and Size.—The *number* of growths in any given case varies. If very large, the mass is usually single, and this remark especially applies to those tumors which grow from the sinuses. They are very often multiple and irregularly distributed. A skull in St. George's Hospital Museum shows no less than nineteen exostoses. The *shape* of these tumors varies greatly. Some are rounded elevations, others assume a conical shape, others are pointed and spine-like, and others most irregular and bossy. Occasionally they have a pedicle, and this may give them a very peculiar outline on section.[4] The majority, however, possess a broad base. Their *size* is equally variable. Some ivory exostoses may be met with as small as little peas; and they commonly do not exceed the size of a hazel-nut. The cancellous tumors are often larger, and may indeed attain a considerable size. The largest bone masses, however, belong to those tumors that spring from the sinuses.

Symptoms.—As a rule, these growths, when external, cause absolutely no symptoms, although those of inflammatory origin may be at first associated with vague pains, worse at night and increased by pressure. Their rate of growth is slow, and is measured by years, and they may at any time become stationary. The enostoses may also cause no trouble, but in some cases they induce brain disturbances, shown by such symptoms as severe headache, convulsions, epilepsy, amaurosis, deafness, and partial paralysis. In one case at least (Lecat's) the patient died of compression, and M. Gayraud speaks of a patient dying with symptoms of meningitis.[5] Those near the orbit may grow into that cavity, and cause protrusion or destruction of the globe; or in like manner they may invade, to some extent, the cavity of the nose or pharynx. The exostoses are readily recognized by their bony hardness, harmless character, extremely slow growth, and absolute fixity. The existence of enostoses can merely be suspected, and then only in cases where brain symptoms have been produced. In confirming such a suspicion, the points of most value would be a history of syphilis or of previous injury, the discovery of exostoses on the surface, and a knowledge of the doctrines of cerebral localization.

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[1] See instances quoted by Sir P. Hewett, loc. cit., p. 3.

[2] Loc. cit., p. 4.

[3] Loc. cit., p. 6.

[4] Quain, Trans. Path. Soc. Lond., vol. iii. p. 149.

[5] Dict. Encycl. des Sc. Med., Art. Crâne, p. 528. 1879.

Treatment.—As exostoses are innocent, and seldom cause even mechanical inconvenience, they should be let alone. If any external tumor is large enough to cause mechanical trouble, it will also be too large to remove. If with an exostosis one has reason, from localized brain mischief, to suspect a corresponding enostosis, the part may be trephined if the mass be small; or, in any case—especially cases with a history of distinct previous injury—where the cerebral disturbance is thoroughly well localized, the skull may be trephined for suspected enostosis. Many external tumors, some of great size, have been removed from the skull in past times; but such operations must be regarded rather as relics of the barbarian age of surgery. The accounts of some of these proceedings with hammer, chisel, and saw, are fearful to read.[1] In all cases with a history of syphilis, appropriate treatment should be adopted.

FUNGUS OF THE DURA MATER.

This term is applied to certain tumors which, springing from the dura mater, in time perforate the skull and appear externally beneath the scalp.

Pathology.—Many tumors of various kinds may have their origin in the dura mater, but it is only a very small segment of them that ever make their way through the cranial bones. There are, for example, fibrous, fatty, and osseous tumors of the dura mater.[2] These never perforate the skull. On the other hand, growths arising from other parts within the cranial cavity, besides the dura mater, may under certain circumstances penetrate the bone and appear superficially. Thus, sarcomatous growths from the arachnoid may perforate the skull, and Lancereaux[3] cites a case of "lipoma" of the pia mater, in which the intracranial tumor was continuous through a deficiency in the skull with a like tumor beneath the scalp. It is probable that this particular growth was congenital. Carcinoma of the brain also may project externally after having made a hole in the bones that cover it.[4] The same may possibly be said of some sarcomata of the brain, and of malignant and sarcomatous growths from the pia mater. All these examples, however, of perforating tumor are extremely rare. It is indeed quite the exception for growths from the brain or softer meninges to penetrate the bone, and thus it happens that in nearly all instances of such perforation the tumor has its origin from the dura mater.

Fungus of the dura mater may occur either as a *primary*, or as a *secondary* tumor. In the latter instance it is due to metastasis in connection with a like growth or growths elsewhere. In some few instances the growth may spread to the dura mater from neighboring parts, as for example, from the orbit.

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[1] In some of these cases the dura mater was freely exposed; in other instances the surgeon hammered at the patient's skull for three or four hours at a sitting, and applied the trephine some six or eight times.

[2] See for examples, Path. Soc. Trans., vol. vii. p. 1; vol. viii. p. 13; vol. x. p. 10. Lancet, vol. i. 1872, p. 147; vol. ii. 1873, pp. 660, 837, etc.

[3] Traité d'Anatomie Pathologique, tome ii. première partie, p. 448. Paris, 1879.

[4] Ball et Krishaber, Dict. Encyl. des Sc. Méd., Art. Cerveau (Pathologie), p. 439. 1879; Malespine, Thèse de Paris, No. 14, 1846.

The primary tumors are nearly always single, the secondary tumors are not infrequently multiple. Moreover, the growth of the secondary masses is usually more rapid than is that of the primary forms of the disease.

Structure.—As regards structure, these growths from the dura mater are *sarcomatous.* With reference to the primary tumors, I think that this statement may be accepted absolutely, but there is some slight and doubtful evidence in support of the assertion made by some that certain of the secondary forms of the malady may be carcinomatous. Less recent observers almost invariably speak of these tumors as cancerous, but there can be little doubt, from the descriptions which they give, that they dealt with sarcomatous new growths. These tumors indeed have in a marked degree the clinical and physical features that distinguish the sarcomata from the carcinomata. They are, as a rule, well encapsuled; they displace rather than invade the parts around (frequent reference is made to the ease with which they shell out on post-mortem examination); they usually attain a large size before they break down; their rate of growth is usually less rapid than that observed in most carcinomata; they seldom induce glandular enlargements; and, lastly, they are often attended by metastasis. All these features are appropriate to sarcoma and not to carcinoma. Lancereaux[1] and other observers assert that metastatic carcinoma never occurs in the dura mater, and in, I think, all of the more recent accounts given of the microscopic aspect of these fungous growths, it has been shown that they were sarcomatous. The following may be taken as examples of the cases that appear to support the view of the possibility of metastatic carcinoma of the dura mater. Dr. Williams[2] records the case of a female, aged fifty-six, who had presented a scirrhus of the breast for ten years. For five years she had had "cancer of the abdomen." Scirrhous tubercles afterwards appeared on the skin of the chest and abdomen. After certain head symptoms she died. The dura mater presented many round and firm nodules of "cancer." In this case the report is hardly full enough, and the long duration of the breast tumor is somewhat opposed to the diagnosis of scirrhus. Dr. Habershon[3] reports the case of a female, aged twenty-nine, who had had a scirrhus of the breast that had recurred after removal. She developed fungus of the dura mater. At the autopsy, many nodules were found on the dura mater, and there was besides "cancer" of the clavicle, ribs, humerus, bronchial glands, liver, and pleura. A drawing is given of the microscopic structure of the fungus, showing irregular cells in alveoli. Here the age of the patient is strongly against the notion of scirrhus, and much in favor of the diagnosis of sarcoma of the breast. The extensive metastases also are extremely suggestive of sarcoma, and it is striking that there is no mention of any glandular implication in the axilla. Many cases,[4] akin to these, have been put on record, and it must be confessed that they do not satisfactorily demonstrate the existence of metastatic carcinoma of the dura mater.

It would appear that in a majority of instances this sarcomatous fungus is of the spindle-celled variety. In several cases it has been a round-celled sarcoma (and these are probably the growths mistaken for soft carcinoma); in other examples it has been described as a myxo-sarcoma, a glio-sarcoma, etc.

It must not be supposed that even the majority of the sarcomata of the dura mater perforate the skull. The majority do not perforate, but rather grow towards the brain and spread out between the dura mater and the bone. Some may grow deeply into the brain. It is obvious, moreover, that such of these tumors as grow from the base of the skull cannot well perforate unless located in certain situations. The course of the perforating tumor is as follows: It commences as a small, round nodule on, as a rule, the outer surface of the dura mater. As it increases, the bone adjacent to it undergoes slow absorption, and in time a hole is made which allows the morbid growth to escape. The holes thus formed are generally roundish, they present sharp and irregular edges, and show usually a greater destruction of the inner than of the outer table. Many older writers speak, therefore, of the bone being carious. In all cases the bone appears to be absorbed, and not to be infiltrated and thereby destroyed by the morbid growth. The tumor itself is well encapsuled, and, as a rule, easily separated, not only from the adjacent parts, but also from the dura mater itself. When the growth has reached the surface, it spreads rapidly over the skull, stretches the scalp, and ultimately—if the patient survives—breaks through the skin as a necrosing, suppurating mass. As a rule, the sarcoma spreads at the same time some way between the dura mater and the bone, and it may in any instance grow extensively in the direction of the brain.

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[1] Op. cit., tome ii. p. 393.

[2] Path. Soc. Trans., vol. ii. p. 163.

[3] Path. Soc. Trans., vol. vi. p. 321.

[4] For an account of many such cases, see an Article by Dr. J. W. Ogle, On Morbid Growths of Brain and Cord, etc., in British and Foreign Med.-Chir. Rev., vol. xxxv. p. 486 *et seq.* 1865.

As regards *seat*, the true fungus is met with on the vault, and the bones most frequently involved are the parietal, then the frontal, then the occipital or temporal together, perhaps with the great wing of the sphenoid. It may project into the orbit, nose, or pharynx, or may escape through the pterygo-maxillary fossa.[1]

No *cause* can in most instances be ascribed for these growths, although very often they have appeared to follow upon an injury.[2] In some cases the tumor would seem to have been congenital. Fungus of the dura mater is equally common in the two sexes, and the most frequent period of life for it is between twenty and forty. It has been met with in young children; Louis, for example, records a case in a child, aged two years.

Symptoms and Diagnosis.—In most cases no symptoms precede the appearance of the tumor, the external tumor itself being the first thing noticed. In other instances, certain cerebral symptoms are observed as preliminary to the appearance of the growth, and these symptoms may be somewhat severe. They take the form of severe headache, or of violent neuralgic pains about the skull, of nausea or vomiting, of vertigo, of some confusion of ideas. In the severer instances there may be convulsions, partial or complete loss of sight or hearing, and slight muscular paralysis. Before the fungus actually appears above the surface, a soft spot of thinned bone may perhaps be felt, that crackles on pressure. Louis[3] records a case in which the discovery of the tumor was made by a barber while shaving the patient's head. He noticed a faint sensation like the crackling of parchment when his razor passed over a certain spot. In a few days a tumor appeared at that spot. The external growth is at first small, flat, and firm. It exhibits pulsations transmitted to it from the brain, and can usually be reduced on pressure. This reduction makes evident a sharp-edged aperture in the skull, and the act itself may cause sudden pain to the patient, and induce vertigo, stupor, or even complete insensibility. As the mass increases it becomes rounded or bossy, and presents a distinctly constricted base. It becomes also softer and more elastic, and may appear to fluctuate at places. It is no longer reducible, and exhibits no pulsation, although in some instances it may present a feeble pulse due to its contained bloodvessels, and not to impulses transmitted from the brain. The scalp becomes stretched over the prominent, growing mass; becomes hairless, thinned, and purplish; and in time perhaps gives way over a soft, fluctuating spot. So extensively may the tumor break down, that the finger introduced through the gap in the scalp, may feel the aperture in the skull. From this giving way of the scalp, severe hemorrhage may ensue. The tumor may attain a large size before the skin yields. Louis[1] records a case in which the growth was thirteen inches in circumference and seven inches in height, and on removal weighed four pounds and six ounces. Tumors of almost equal size have been noted by others. Sometimes the growth is attended by much pain. Louis imagines this to be due to the pressure of the mass against the sharp edges of the hole in the bone, and cites a case in which the patient found relief from severe pain and grave brain symptoms by lying in the position that caused the tumor to be the least prominent.

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[1] Sir Wm. Lawrence, Lancet, August, 1853.

[2] For instances, see Louis's well-known monograph on "Fungous Tumors of the Dura Mater." Memoirs of the Academy of Surgery. Sydenham Society's Translation, p. 83. 1848.

[3] Loc. cit., p. 85

During the progress of the case there may be cerebral symptoms—such as headache, impairment of sight and hearing, vertigo, stupor, spasms, etc.—but more commonly these symptoms are absent. Louis reports a case in which the tumor was twelve inches in circumference, but in which the patient presented no symptoms of this kind.

In the matter of *diagnosis*, the general features of the case will be such as usually point out a sarcomatous growth. As long as the tumor is small, is reducible, and presents pulsations, little difficulty can occur in the diagnosis. It may in this stage be mistaken for encephalocele, from which, however, it should be early distinguished by the fact that the hernial tumor is congenital, is restricted as to its site, is softer to the touch, and does not present the comparatively rapid and deliberate growth of the so-called fungus. Vascular growths from the dura mater are preceded by some injury or disease of the bone (Heineke), and present, in addition to a strong pulsation in all their parts, a distinct bruit. When the tumor has attained some size and become fixed, and has lost all pulsation, the diagnosis may be more difficult. It can, however, scarcely be confounded with any growth other than a sarcoma of the cranial bones, and the points of difference between these two forms of sarcoma are, I think, well marked. The sarcomata from the bone are harder than those from the dura mater, and are, indeed, often covered with a cap of bone; they show less constriction at their base, and present in that situation very commonly a distinct osseous rim; moreover, they present in their interior bony trabeculæ that can be detected with a fine needle. An incision made, as Heineke suggests, at the base of the fungus, would show that the edge of the bony gap had no connection with the substance of the growth, as it has in the case of sarcoma arising from the cranium. When the fungus appears in unwonted situations, errors in diagnosis are very prone to occur; and as an example of such I may cite a case reported by Dr. McKenzie,[2] of Glasgow, in which the fungus pierced the great wing of the sphenoid bone, and, appearing externally, was mistaken for an enlarged gland.

The *prognosis* in these cases is bad, the malady, left to itself, being invariably fatal. Death is due usually to increasing exhaustion and marasmus, or to implication of the softer meninges and brain. The duration of the disease is very variable; it may last for years,[3] and on the whole does certainly exhibit a less rapid growth than do the majority of sarcomata. Some cases are, however, recorded, in which there has been a very rapidly fatal termination.

As regards *treatment* little is to be said. The external tumor should be protected from pressure and injury, and such general and local symptoms as arise should be met by the usual modes of treatment. If the mass ulcerate, it may be well to destroy the more prominent parts with the actual cautery. This procedure would greatly lessen for a while the suppurative action, and would add to the comfort of the patient. Operations for the entire removal of the mass are not to be advised, for such operations would fall short of their purpose, unless with the tumor was excised a considerable portion of the dura mater. Whether antiseptic surgery can render such procedures less fatal than they are at present, remains to be seen. These tumors have been subjected to a vast number of operations of various kinds at the hands of one surgeon and another, and certain of these so-called "modes of treatment" have been of the most horrible and reckless character. Many times have these sarcomata been incised, with in some instances a fatal hemorrhage; many times have they been ligatured, and in a still greater number of cases subjected to the action of some caustic. Of more elaborate operations, the performance of Berard[1] may well be taken as a conspicuous example. This surgeon, in an attempt to excise a fungus of the dura mater, made no less than sixteen trephine holes in a patient's skull. The unfortunate individual lived twenty-four hours. In only three instances have operations for the removal of tumors from the dura mater proved other than rapidly fatal. The patients in these instances were operated upon respectively by Grosmann,[2] Pecchioli,[3] and Orioli;[4] and in each case a cure of the disease is said to have resulted.

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[1] Loc. cit., p. 112.

[2] London Medical Gazette. 1838.

[3] Louis gives a case that existed for seven years, and another in which the tumor remained quiescent for twelve years, and then took on rapid growth. (Loc. cit., p. 112.)

INTRACRANIAL ANEURISM.

Intracranial aneurisms are not uncommon. They are mostly situated at the base of the skull, about the circle of Willis, and more often affect the carotid than the vertebral segment of that anastomosis. According to Quincke,[5] the artery of the fossa Sylvii is the one most frequently affected, being involved in forty per cent. of all cases. The aneurism is apt to be found at the bifurcation of any given vessel. In size these tumors are as a rule small—some are very small; the average dimensions would be from those of a pea to those of a hazel-nut. Tumors of large size, however, have been met with; thus a case of multilocular aneurism of the left posterior cerebral artery, the size of a small apple, has been reported by R. W. Smith.[6] Aneurisms in this situation differ from aneurisms elsewhere in certain respects. In the first place, they do not observe the same restrictions with regard to age, but occur in the young with almost as much frequency as in those more advanced in life. Then again aneurisms elsewhere are—taken as a whole—of much more common occurrence in men than in women, whereas in these intracranial aneurisms, that disproportion is very much less marked. Lastly, intracranial aneurisms appear to be often independent of preceding local changes in the vessels, and are probably due in a majority of cases to embolism. They are indeed often found associated with endocarditis and embolic lesions of various parts, especially in the young. In anatomical structure, moreover, they present certain peculiarities, which it is not necessary to discuss in this place. In growing they are apt to press rather upon the brain than upon the unyielding bone, although cases are recorded of absorptive destruction of some of the bony parts of the base of the skull. Their progress is most uncertain, and as a rule very slow. In three-fourths of all cases, a rupture of the aneurism is the mode of termination.[1] Several cases of spontaneous cure are recorded. Such are some of the chief facts in connection with intracranial aneurism.

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[1] Gazette Médicale, tome i. p. 735. 1833.

[2] Stolz, Thèses de Haller, tome i. p. 169.

[3] Gaz. Méd. 1838.

[4] Bull. delle Scienze Mediche, Maggio, 1834.

[5] Ziemssen's Cyclopedia of the Practice of Medicine, vol. vi. page 440. 1876.

[6] Dublin Journal of Medical Science, vol. xxv.

It must be owned, however, that (in the present state of our knowledge, at least) these tumors have little concern with practical surgery. This concession must be made with some reservation, and must not include at least two intracranial aneurisms, viz., aneurism of the internal carotid artery, and aneurism of the middle meningeal. These aneurisms will receive separate consideration presently. With regard to the rest—the bulk of intracranial aneurisms—it may be said that they are at present excluded from the province of practical surgery for a twofold reason. The first of these deals with diagnosis. The majority of these aneurisms have not been recognized until the patient has reached the post-mortem room. In very many cases the tumor has produced absolutely no symptoms, and it has been only when death has occurred from other causes that the unsuspected aneurism has been discovered. In other cases, the only symptoms have been those that have immediately preceded death, and that have been due to the rupture of an aneurism of whose previous existence no evidence had been given.

In the most favorable cases, the diagnosis can be little more than conjectural, and would certainly not be clear enough to justify an operation, even presuming any operation to be proposed. The existence of a cerebral tumor may be recognized, but when the nature of the tumor is discussed, and the direct question asked—Is it aneurismal?—a chaotic district in medical knowledge is exposed, and a positive answer is seldom to be obtained. Immense progress has of late been made in this department of medicine, and no doubt in time this void will be filled up, but at present no basis is afforded for active surgical practice.

In the second place, supposing the diagnosis to have been made, can surgery do anything to cure or relieve the patient? At present the answer must certainly be in the negative—bearing in mind that we are quite excluding from these remarks the two special aneurisms already alluded to. Four large vessels enter into the circle of Willis; and so large are their contributions, and so free their anastomoses, that ligature of one, or even of two of the supplying trunks, would have but very doubtful prospects of success. Presuming that both carotids were tied, the circulation through the vertebrals would still be too vigorous to allow of much hope of good result. Indeed, I think it may safely be said that these particular intracranial aneurisms are at present beyond the reach of any surgical treatment. It would be foreign to the purpose of this work to discuss the symptoms that might be associated with these aneurisms; such an inquiry would open up a subject of immense interest and great complexity—the diagnosis and localization of cerebral tumors—a subject that is however at present more the concern of the physician than of the surgeon.

Aneurism of the Internal Carotid Artery at the Cavernous Sinus.—The symptoms of this aneurism vary somewhat, but, taken as a whole, are fairly characteristic. The symptoms often appear suddenly after an injury of some kind, or, on the other hand, may develop spontaneously, and assume a very leisurely and chronic course. There is usually frontal headache, that is often severe and associated with exacerbations, and that is sometimes located by the patient at the back part of one orbit. In addition, a rasping or sawing noise in the ears—or more particularly in the ear of the affected side—is complained of. With this there is not unfrequently vertigo, and an inability to stoop, or to hang down the head. If the patient sleep with the head low, he is apt to be troubled with fearful dreams, and to wake up terrified.

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[1] Ball et Krishaber, Dict. Encyclop. des Sciences Méd., Art. Cerveau, p. 448. 1879.

On the whole, however, symptoms due to brain pressure are not observed with this aneurism, or only to some slight degree—the growth of the tumor, and its injurious contact with the brain, being opposed by the dura mater. Vomiting may occur, but is much less common than it is in other cerebral aneurisms, and epileptic attacks, muscular spasms, gross palsies, and intellectual troubles, are all either entirely absent or at least quite exceptional. The special symptoms depend upon lesion of the nerves in the cavernous sinus, the nerves most usually affected being the third and fifth, and then the fourth or sixth. The optic nerve appears to be seldom pressed upon. The special symptoms, therefore, will probably commence with ptosis, dilated pupil, and external strabismus, or with severe neuralgia of the first division of the fifth nerve, associated with photophobia, and sometimes with temporary congestion of the conjunctiva.[1] In time, paralysis of the fourth and sixth nerves usually follows, and the eye becomes motionless, but the loss of function in either of these nerves may not occur for a considerable time, as, for example, in Mr. Hutchinson's case, where the paralysis of the superior oblique muscle did not appear until ten years after the commencement of the symptoms.[2] As a rule, the neuralgia gives way to numbness of the forehead and some part of the face. The troubles of vision consist usually of loss of accommodation and diplopia. But there may be optic neuritis, and absolute blindness in the eye of the affected side.[3] It is unnecessary perhaps to observe that all these pressure symptoms are strictly limited to one side. In addition to these evidences, a very distinct blowing bruit can be heard on auscultation over the affected side of the head, more especially about the anterior temporal region; and in those cases in which the cavernous sinus is much compressed, there may be vascular engorgement of the globe with undue prominence of the eyeball. This aneurism may undergo spontaneous cure, as occurred in the celebrated case reported by Mr. Hutchinson, and just referred to.

With regard to *treatment*, the only operative measure to be advised is ligature of the common carotid artery. This operation should not be performed until the diagnosis has been clearly established, and other means have failed to effect improvement. One must also assume that no obstacle to the operation is offered either by the patient's general health, or by the condition of the main artery in the neck. One such operation has been recorded. It occurred in the practice of Mr. Coe, of Bristol.[4] The patient was a woman aged fifty-five, and the operation resulted in a complete cure.

ANEURISM OF THE MIDDLE MENINGEAL ARTERY.—Aneurisms of this vessel are extremely uncommon, and are usually, if not always, due to injury of some kind. They have a tendency to perforate the skull, and to appear externally beneath the scalp. Before such perforation occurs, the nature of the tumor may be a matter of much uncertainty. The symptoms before perforation are those due to pressure upon the brain. The patient complains of severe and often well-localized headache, of vertigo, of a constant buzzing in the ears, and of a tendency to faintness, and perhaps to vomiting. There may be moreover spasms in some particular set of muscles on the opposite side, or paralysis of those muscles, or even hemiplegia of the opposite side.[5] In addition, the patient will probably complain of a pulsation in the affected district, and on auscultation the aneurismal bruit may be heard. When the tumor perforates the skull, the diagnosis becomes much more evident. A tumor appears over the site of some main division of the middle meningeal artery, it pulsates distinctly, and, if large enough, may give to the fingers a sense of lateral expansion. It feels soft and fluctuating, and has possibly a slight thrill noticeable to the touch. On pressure being applied, the tumor will be found to be reducible, and, after such reduction, the hole in the bone may possibly be detected. This reduction moreover is not apt to be associated with cerebral symptoms. Pressure on the common carotid of the affected side causes diminution, or temporary disappearance, of the tumor, whereas pressure upon the opposite carotid increases the size of the mass. On auscultation, a distinct aneurismal bruit is to be heard over and around the site of the tumor. The diagnosis would also be aided by the history of the case, and by a knowledge of the symptoms experienced by the patient. In one case,[1] where a tumor had formed from perforation of the skull, the mass was mistaken for a cyst, and an operation was performed for its removal. Severe hemorrhage occurred from the incision. It could not be checked, and soon led to a fatal result. The only operative *treatment* applicable to these aneurisms is ligature of the common carotid of the affected side. Kremnitz[2] records a case in which this operation was performed for a meningeal aneurism that had perforated the skull, and had formed a large external tumor. It resulted in a complete cure, the hole in the skull being protected by the application of a silver plate.

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[1] See a case recorded by Dr. Humble. Lancet, vol. ii. page 489. 1875.

[2] Trans. Clinical Soc. Lond. 1875.

[3] J. W. Ogle, Brit. and For. Med.-Chir. Review, vol. xxxvi. page 493. 1865.

[4] Association Journal, page 1067. 1855.

[5] Follin et Duplay, Traité de Path. Ext., tome iii. p. 584. 1869.

Chronic Hydrocephalus.

This term is applied to a disease characterized by certain accumulations of fluid within the cranial cavity. This fluid may be within the ventricles (internal hydrocephalus), or in the arachnoid sac (external hydrocephalus).

Internal hydrocephalus is the usual form of the disease. The accumulation of fluid in the arachnoid sac is rare, and, according to some authorities, is merely an accidental complication of the commoner form. Others maintain the independent existence of external hydrocephalus. The disease (considered generally) is as a rule congenital, or appears within the first six months after birth. It may however occur at any time before the sutures unite, or even after that event.

Internal Hydrocephalus.—The fluid, as just observed, usually occupies the ventricular cavities, and as a rule all those cavities (viz., the lateral, the third, and the fourth ventricles). The dilatation is not always uniform, and not unfrequently involves one lateral ventricle or one part of such ventricle more considerably than the rest of the general cavity. The affected ventricles become immensely distended, and assume a rounded outline. The ganglia appear flattened out, and the various commissures stretched, or even removed. Owing to the ventricular enlargement, the convolutions of the brain become as it were unfolded, and more or less obliterated, and the cerebral mass between the ventricles and the surface becomes greatly thinned by the increasing distension. In certain severe cases, this brain matter may be reduced to a layer no thicker than one-half or one-quarter of an inch, and instances are recorded in which a mere film of brain tissue has in places bounded the mass of fluid in the ventricular cavities. It is possible for this thin layer to give way, and for the contained fluid to find its way into the arachnoid sac.[1] The quantity of dropsical fluid varies from a few ounces to quarts. In appearance it is clear, limpid, or slightly yellow, is of somewhat higher specific gravity than cerebro-spinal fluid, and contains but very little solid matter, in the form mainly of albumen and salts of sodium.

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[1] Krimer, Journ. des Progrès des Sciences Méd., tome x. p. 237.

[2] Kremnitz, Deutsche Zeitschr. für Chirurgie, Bd. iv. S. 473. 1874.

The *cause* usually ascribed for this disease is chronic inflammation of the lining membrane of the ventricles, while among less frequent causes are classed excess or deficiency of blood supply to the brain, with the various organic effects that follow such conditions, and certain malformations of the brain and its membranes.

Effects on the Skull.—The head enlarges mainly at the expense of its upper and lateral portions. The fontanelles become more open, and the sutures wider, while the bones of the vertex gradually recede from one another. The frontal bone is pressed forwards, the parietals backwards and outwards, and the occipital so much downwards that its vertical part may become almost horizontal. The enlargement is seldom quite symmetrical, and the head as a rule becomes conspicuously flattened at the top. The orbital plates of the frontal bone become depressed and oblique in direction, so that the orbits may be reduced to mere chinks. This change in the base of the skull is diagnostic of ventricular dropsy, as it never occurs in cases of external hydrocephalus. At the same time, it must be remembered that the orbital plate would not be affected in those rare cases in which ventricular dropsy had occurred after consolidation of the bones at the base of the skull.[2] At the sides of the cranium, the great wing of the sphenoid and the squamous bones are driven out, the temporal and zygomatic fossæ are filled up, and, if the deformity be severe, an appearance is given to the face as if the cheeks were greatly blown out. The scalp looks thin and tense, is covered with scanty hair, and presents on its surface many prominent veins. Fluctuation may generally be felt in the course of the open sutures, and these parts may sometimes be seen to sink and rise with respiration. With the greatly enlarged head the small and often emaciated face is in striking contrast. Owing to the frontal enlargement, the face has a somewhat triangular outline with the apex at the chin. If the orbital plate be much depressed the eyes are unduly prominent, and have an inclination downwards, so that often a good deal of the pupil may be concealed by the lower lid.

Symptoms.—Enlargement of the head is by no means of necessity the first symptom. Very often—especially in congenital cases—this enlargement is preceded by cerebral symptoms, such as convulsions, rolling of the eyes, squinting, paroxysms of screaming, restlessness, etc. The child wastes and becomes puny and ill-nourished. It cannot well support its head, and prefers to lie down rather than to sit. If it lives until it is old enough to walk, its gait is usually slow and cautious, like that of a decrepit old man; it is frequently idiotic, and is apt to be fretful and to exhibit paroxysms of passion. Children thus affected are liable to the brain disturbances already mentioned, and, in addition to these, may become the subjects of spasmodic croup, of muscular spasms in various parts of the body, and of muscular rigidity in one or more limbs.

Prognosis.—Death is the usual termination of these cases, and, unless it occurs at or soon after birth, commonly supervenes during the first or second years of life. The immediate cause of the fatal result may be exhaustion simply, or coma, or convulsions, or even acute cerebral mischief. Some children survive a few years, and some may even attain adult age, but such cases are very rare. In these instances the skull becomes in time solidified by the growth of new centres of ossification in the membranous parts, and by the increase also of the existing bones of the vault. The fluid ceases to increase, but it is doubtful if is ever reabsorbed except under most unusual circumstances.

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[1] Bright's Reports, vol. i. part i. page 433.

[2] Hewett, The Deviations of the Base of the Skull in Chronic Hydrocephalus; St. George's Hosp. Reports, vol. i. page 27. 1866.

EXTERNAL HYDROCEPHALUS.—This condition is referred to three causes:[1] (1) to escape of fluid from ventricular dropsy; (2) to congenital atrophy of the brain; (3) to hemorrhage into the arachnoid sac. Apart from the absence of alteration in the base of the skull, it is doubtful if there are any absolute signs whereby an independent, external hydrocephalus may be diagnosed from the more common form of the disease. All the remarks, moreover, made upon this latter affection may be considered as also applicable to the form now under notice. Legendre[2] distinguishes the form due to hemorrhage by the facts that it is never congenital, that the head does not attain the size commonly seen in internal hydrocephalus, and that it is always preceded by convulsions, or other evidences of cerebral disturbance.

Treatment of Hydrocephalus.—With the general treatment of hydrocephalus the present article has no concern. The local treatment that has been proposed in certain cases consists (1) in the application of pressure, and (2) in paracentesis.

Pressure to the skull is maintained by means of strapping, or by an elastic bandage, the latter being the most suitable appliance. This treatment is applicable to nearly all those cases that are not absolutely hopeless, and that do not show evidence of a rapidly fatal termination. It can be regarded merely as a palliative measure, and may no doubt restrain the increase of the dropsy, at least for a while. The results of the treatment have been unsatisfactory, and for the most part negative. If it has done no good, it has at least done no harm, if exception be made of a few cases in which too vigorous pressure has induced symptoms of compression of the brain, and, in a case of Trousseau's, even death. The best mode of applying compression by means of plaster, is that advised by Trousseau, who gives the following directions. The plaster should be in strips one-third of an inch broad, and should be applied "1st, from each mastoid process to the outer part of the orbit of the opposite side; 2d, from the hair at the back of the neck, along the longitudinal suture, to the root of the nose; 3d, across the whole head, in such a manner that the different strips shall cross each other at the vertex; 4th, a strip is cut long enough to go thrice around the head. Its first turn passes over the eyebrows, along the ears, and a little below the occipital protuberance, so that the ends of all the other strips shall project about one-quarter inch below the circular strip. These ends are next to be doubled up on the circular strip, and its remaining two turns are then to be passed over them just in the same direction as the first turn."[3]

Paracentesis.—Much difference of opinion exists as to the value of this operation for the relief of chronic hydrocephalus, and it must be confessed that the results of paracentesis have so far not been very satisfactory. West[4] collected fifty-six cases in which tapping had been performed, and out of this number he considered that cure had followed in only four instances. It must, in the first place, be allowed that the operation is not in itself dangerous, and that it is applied to a disease the prognosis of which is extremely grave. This point therefore can be urged in favor of the operation, that it is not likely to do much harm even if it effects little good. There is no doubt, however, that in many cases it has been followed by temporary relief, even if cure has not ultimately followed. The following appear to be the cases most suitable for paracentesis. As a general rule it may be practised in cases of great enlargement, with steady increase. In cases of external hydrocephalus, it is more likely to be followed by a good result than in cases of ventricular dropsy. It would be inapplicable to cases due to cerebral mal-development, and it is unfortunate that such cases cannot always be diagnosed, inasmuch as the functional disturbances that accompany the disease bear no constant relation to the amount of organic defect. Paracentesis is likely to fail in congenital cases, in cases associated with preceding acute cerebral disease, and in cases marked by extreme mal-nutrition. Indeed, in such instances, its employment is rather to be condemned. Malgaigne[1] advises the operation: 1st, in patients under four months old, in whom the disease appears stationary; 2d, in children beyond that age, but who have not yet reached the period of complete cranial ossification, in whom the disease is increasing and threatening life.

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[1] West, Diseases of Infancy and Childhood, 8th ed., page 130. 1874.

[2] Legendre, Recherches Anat. Path., p. 135. Quoted by West.

[3] West, op. cit., page 133.

[4] Medical Gazette, April, 1842.

The operation should be performed with a very fine trocar, which should be entered in the coronal suture, about one inch from the anterior fontanelle. The instrument should be thrust downwards, and a little backwards. Only a few ounces of fluid should be drawn off at a time, and the operation should be repeated at intervals of from a few days to a few weeks, according to the condition of the patient, and the rate at which the dropsy is increasing. Compression of the skull should be maintained, both during and after each operation. Dr. Thompson,[2] of Newcastle, reports a case in which two tappings ended in cure.

In some instances *iodine injections* have been associated with paracentesis, but so far with unsatisfactory results. Sir James Paget[3] treated a case in this manner, throwing in about three ounces of a solution composed of ten grains of iodine and twenty grains of iodide of potassium to one ounce of water. The child died of convulsions three days after the second injection had been employed.

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[1] Malgaigne, De la Ponction du Crâne dans l'Hydrocéphale chronique. Bull. de Thérap., tome xix. p. 226. 1840.

[2] Med.-Chir. Trans., vol. xlvii. page 289. 1864.

[3] Medical Times and Gazette, vol. ii. page 613. 1860.

GENERAL SCHEME OF THE TUMORS OF THE VAULT OF THE SKULL.

ARRANGED FOR DIAGNOSTIC PURPOSES.

I.—Tumors that Communicate with the Cranial Cavity.

[Common features: Reducibility. Pulsation. Increase on expiration. Hole in bone often to be felt. May be cerebral disturbance on pressure or attempted reduction.]

A. Congenital.
  1. *Encephalocele.*
  2. *Meningocele.*
  3. *Hydrencephalocele.*
  4. *External cephalhæmatoma*, communicating with an internal cephalhæmatoma through a perforation in the bone.

B. Not congenital.
  5. *Fungus of dura mater.*
  6. *Aneurism of middle meningeal artery* that has perforated the bone.
  7. *External venous tumor* communicating with the superior longitudinal sinus.
  8. *External collection of pus* communicating with an internal collection through a perforation in the bone.

II.—Tumors that do not Communicate with the Cranial Cavity.

A. Tumors that pulsate.
  1. *Aneurism.*
  2. *Arterial erectile tumor.*
  3. *Certain sarcomata of the cranial bones.*

B. Gaseous tumors.
  4. *Pneumatocele*, the only tumor tympanitic on percussion.

C. Tumors with fluid contents.
  5. *Simple hæmatoma*, either (a) in substance of scalp; (b) beneath aponeurosis; or (c) beneath pericranium; blood may be coagulated.
  6. *Cephalhæmatoma*, in infants only; mostly over parietal bone.
  7. *Abscess*, either (a) in substance of scalp; (b) beneath aponeurosis; or (c) beneath pericranium.
  8. *Serous cyst*, very rare. *Hydatid cyst* of bone.
  9. *Certain sebaceous* and *dermoid cysts*, whose contents have softened, may appear to contain fluid.

D. Solid tumors.
  10. *Exostosis*,
  11. *Sarcoma and carcinoma of bone*, } deeply seated.
  12. *Dermoid cyst*, contents often fluid,
  13. *Papilloma*,
  14. *Common sebaceous cyst*, contents often more or less fluid, } in substance
  15. *Sarcoma of scalp*, of scalp.
  16. *Solid congenital tumor of scalp*,
  17. *Lipoma.*
  18. *Fibroma.*
  19. *Osteoma* of scalp (?).
  20. *Gumma.*

It must be noted that certain of the tumors in Class I., viz., *fungus of the dura mater* and *meningocele*, may cease to present any evidence of communication with the cranial cavity, and that certain tumors in Class II., viz., *certain sarcomata of the bone*, that have perforated, and *some dermoid cysts*, may acquire some of the signs that are considered to indicate origin from within the cranial cavity.

INJURIES AND DISEASES OF THE EYES AND THEIR APPENDAGES.

BY

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Among the five special senses, royal importance has, at all times, been conceded to sight. The value of the eye, in the animal economy, has drawn to its diseases a never-flagging interest. As we approach this mystic temple to inquire into divine secrets, let us walk lightly, for we are treading on holy ground. Shut off the light of the eye, which is the cheer of the soul, and the blackness of darkness rushes in to overwhelm the stoutest heart. Had not the "drop serene" quenched the orbs of Milton, his ecstatic invocation to Light could never have been conceived. It is said of Shakespeare that when he wrote he dipped his pen in his own heart. That is the main secret of his immortality. The truly scientific spirit is ever humble, supremely desiring to know and to tell the truth. In entering on our favorite study, shall we not bring to bear upon it an earnest and honest intelligence? To this end a brief outline of the structures composing the organ whose injuries and diseases we are to investigate, must inaugurate our work. In the pinching interests of brevity we must assume that the reader has an adequate knowledge of the anatomy and physiology of the eye, which needs only to be refreshed. First in the order of solid importance, let us take up the cavity in which the eye is securely lodged, and successfully discharges its functions.

Anatomy of the Eye.

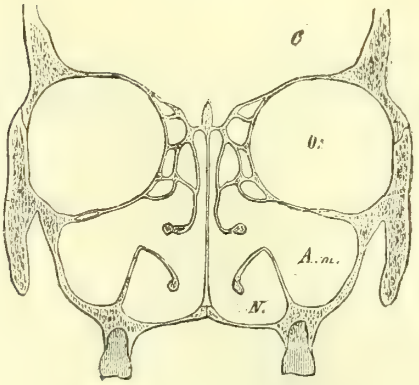
The Bony Orbits.—These are hollow pyramids, with bases presenting forwards and outwards, and apices backwards and inwards. The axes of the two cavities intersect over the sella turcica. This divergence of the orbits affords a larger field of vision and greater circumspection. The most firm and resisting part is the bony ring that forms its base. The prominence of these bony guards, with the nose between them, protects the eyes from the disastrous force of injuries. The upper wall, slightly arched, is formed by the frontal and sphenoid bones, and supports the anterior lobe of the brain. In its middle, the orbital plate is very thin, and liable to be fatally pierced by direct thrusts from below. I recall the case of a man, brought to the hospital without history, and delirious, and who soon died. The end of a small knife-blade was found broken off in this plate, penetrating and causing abscess of the brain. On this wall are found the optic foramen, the pit for lodging the lachrymal gland, a little depression for the trochlea, and a supra-orbital foramen or notch. The inner wall, furnished mainly by the ethmoid, is smooth and parallel with its fellow, completed anteriorly by the lachrymal and nasal process of the superior maxillary. Here is seen the vertical groove in the os unguis that lodges the lachrymal sac, and becomes below the bony nasal duct. The lower wall, made up chiefly by the orbital plate of the superior maxillary, slopes a little downwards and outwards. In it is seen the groove for the infra-orbital nerve. The outer wall, supplied by the malar and sphenoid, is very solid, sloping outwards, and giving divergence to the orbits. The scope of vision thus afforded, supplemented by rotatory movements of the head, enables us to sweep the horizon with our view.

Near the apex of the cavity we find two large fissures, the sphenoidal and spheno-maxillary, giving passage to vessels and nerves; the former communicating with the cavity of the cranium, and the latter with the zygomatic fossa. The motor nerves that supply the extrinsic and intrinsic muscles of the eye, the ophthalmic branch of the fifth nerve, some filaments of the sympathetic, and the ophthalmic vein, all pass into the orbit through the sphenoidal fissure. The infra-orbital artery and nerve pass through the spheno-maxillary fissure, into the groove in the floor of the orbit. In blows on the temple, blood may find its way through this fissure, and give rise to ecchymosis of the conjunctiva. I once saw periostitis following the extraction of an upper molar tooth, the pus passing through this fissure into the orbit, and pointing at the lower and outer margin, below the angle of the eyelids. In fractures of the base of the skull, the crack often passes through the sphenoidal fissure, and gives rise to conjunctival ecchymosis. It may likewise traverse the optic foramen, contusing, tearing, or compressing the nerve, and giving rise to serious disturbances of sight. A sharp instrument may be thrust through the sphenoidal fissure with fatal injury to the brain. A royal example, in the case of Henry the Second, of France, is quoted by authors.

The size of the orbital cavity, with its fissures and foramina, is perceptibly diminished by the periorbita that lines it throughout, continuous at the base with the pericranium, and at the apex with the dura mater. The periorbita is thin and somewhat loosely connected with the bones, being easily separated by extravasations of blood or collections of pus.

In close relation to the orbit, are several cavities in bones, the largest of which is the antrum in the superior maxillary. A thin translucent plate of bone intervenes between it and the socket. High up, it opens into the nose, and is lined throughout by mucous membrane. The antrum is large enough to hold a musket-ball, and instances are on record, in which bullets have lodged there for years. The frontal sinus, at the upper and inner part of the orbit, communicates freely with the superior meatus of the nose, through the infundibulum. The numerous air cells, in each mass of the ethmoid, are separated from the socket only by a thin plate of bone, the os planum. (Fig. 842.)

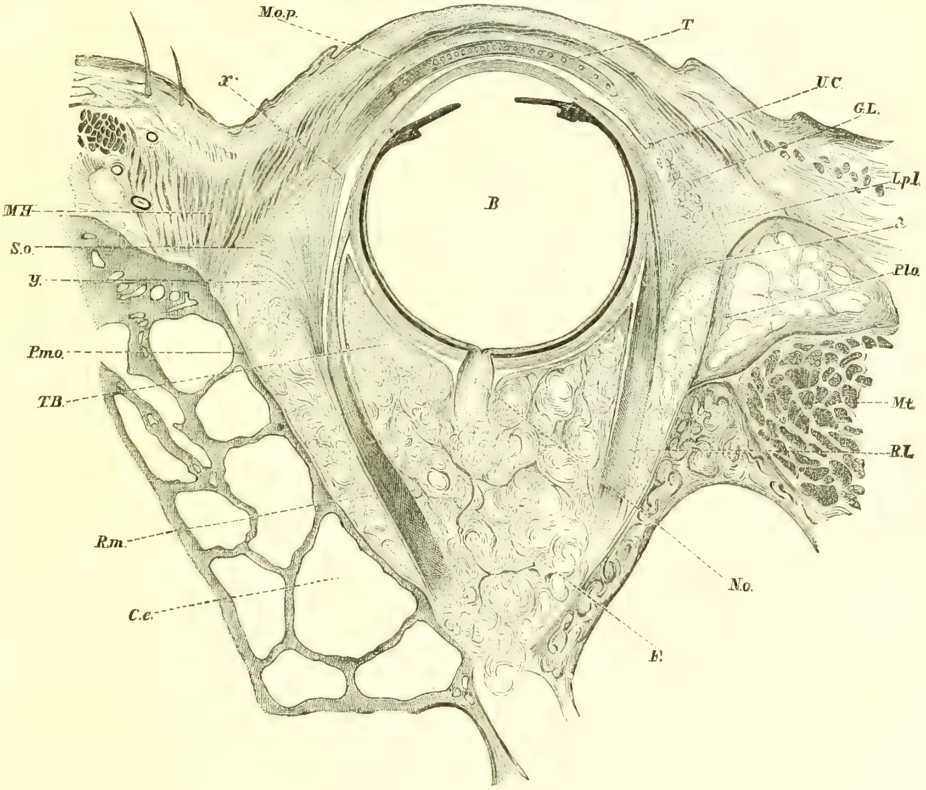
Fig. 842.



Frontal section of an adult skull through the middle of the orbits. *O.* Orbit; *N.* Naris; *A.m.* Antrum maxillare; *C.c.* Cranial cavity. (After Merkel.)

Tumors and accumulations of various kinds in these cavities, are likely to encroach upon the orbit, dislodge the eye, and cause exophthalmus, diplopia, and other serious troubles. I have seen several cases of cyst in the ethmoid, that crowded the contents of the orbit, and had to be treated surgically, to save the eye. Cases of fistula of the frontal sinus, presenting above the tendo oculi, have been sent to me for fistula lachrymalis.

Fig. 843.

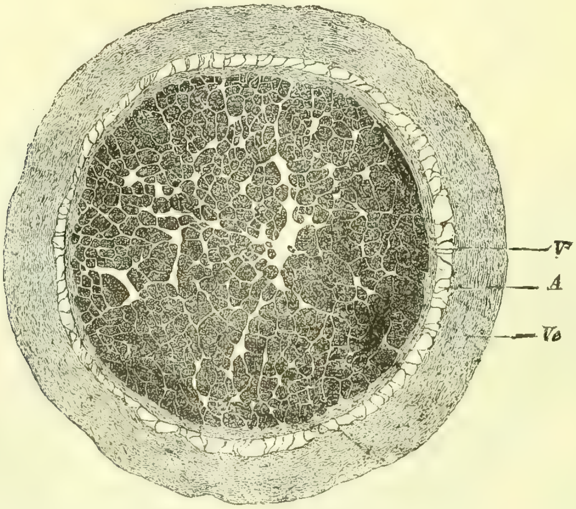


Horizontal section through the orbit of an adult male. *B.* Eyeball; *R.L.* External rectus muscle; *R.m.* Internal rectus; *F.* Orbital fat; *N.o.* Optic nerve; *T.B.* Capsule or fascia of Tenon; *L.p.l.* External palpebral ligament; *G.l.* Lachrymal gland; *S.o.* Orbital septum; *M.H.* Upper part of Horner's muscle (tensor tarsi); *U.c.* Reflexion of conjunctiva; *T.* Tarsal cartilage; *M.o.p.* Orbicularis palpebrarum muscle; *P.m.o.* Internal wall of orbit; *C.e.* Ethmoidal cells; *P.l.o.* External wall of orbit; *M.t.* Temporal muscle; *X.* Junction of capsule of Tenon with conjunctiva of globe; *y.* Fascial termination of sheath of internal rectus; *z.* Fascial termination of sheath of external rectus. × 1.7. (After Gerlach.)

The bony orbit lodges the eye, the optic nerve, the six rotatory muscles and their nerves, sensory nerves, numerous bloodvessels, and a large amount of cellulo-adipose tissue, which gives soft support to the eyeball. (Fig. 843.)

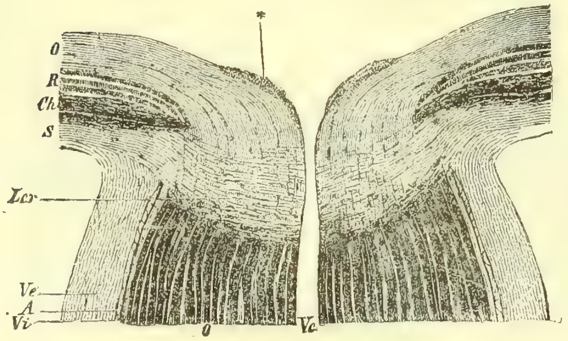
Optic Nerve.—The optic nerve, entering the orbit through the foramen opticum, and measuring about 4 mm. in diameter, runs forwards, in a tortuous manner, to the sclerotic, slightly below and inwards from the posterior pole of the eye, which it pierces in an opening 1.5 mm. in diameter. Its entire length, within the orbit, is 28 or 29 mm. The nerve is closely embraced by a neurilemma, which is continuous with the pia mater, and which sends numerous septa inwards, to divide the fibres into separate bundles. Through these divisions, the nerve trunk is freely supplied with blood. (Fig. 844.) A firmer external sheath, derived from the dura mater at the optic foramen, envelops the nerve and neurilemma, and is laxly connected with the latter by delicate fibrous tissue. The two sheaths of the nerve, thus related, become more firmly united as they approach the sclera. On reaching the ball, the external sheath blends with the sclera, while the other is lost in the choroid.

Fig. 844.



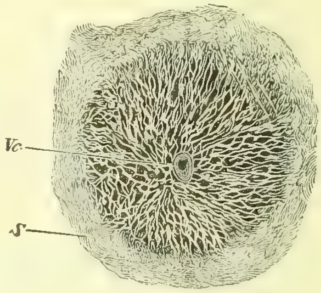
Transverse section of optic nerve a little in front of the entrance of the central vessels. *Vi.* Inner sheath or neurilemma; *Ve.* Outer sheath; *A.* Lymph-space between the two sheaths, a continuation of the arachnoideal space. (After Merkel.)

Fig. 845.



Longitudinal section of the entrance of the optic nerve into the eyeball. *O.* Substance of optic nerve; *Vc.* Space for central vessels; *Vi.* Inner sheath or neurilemma; *Ve.* Outer sheath; *A.* Lymph-space between sheaths; *S.* Sclerotic coat; *Lcr.* Lamina cribrosa; *Ch.* Choroid; *R.* Retina. (After Merkel.)

Fig. 846.



Cross-section of optic nerve at point of passage through lamina cribrosa. *S.* Sclerotic; *Vc.* Cross-section of central vessels. (After Merkel.)

Constricted in passing through the sclera, the nerve changes its color from white to semitransparent gray, due to microscopic modifications in the nerve-fibres as they lose their opaque sheaths. A third covering, between these two, very delicate, and in close relation to the outer or dural sheath, is now described. All the tunics of the brain are thus represented as continued in the sheath of the optic nerve. The intervaginal space, continuous with the subarachnoid spaces of the brain, is liable to serous infiltration from the brain, causing compression of the nerve-trunk. The constriction of the nerve in piercing the lamina cribrosa of the sclera, the sudden bending of the individual fibres as they pass into the retina, the canal in its axis for the central artery of the retina, as well as the opening in the choroid, are all well seen in the annexed cut. (Fig. 845.) Fig. 846 shows a transverse section of the optic nerve. The central artery of the retina pierces the sheath, about half an inch behind the eye, passes to the axis of the cord, and follows it till it enters the fundus and divides into its retinal expansions. The main trunks of the retinal arteries and veins enter and emerge from the centre of the optic papilla.

Eyeball.—In form, the eyeball is very nearly a globe, whence its name. The antero-posterior diameter measures about 24 mm., the horizontal 23.5 mm., and the vertical 23 mm. (Merkel). Just back of the sclero-corneal junction, the globe is retracted as by a tight cord. (Fig. 847.) From the centre of the cornea to the deepest part of this constriction, the curvature is greater than that of the rest of the globe. The back half of the eye is much more uniform in curvature than the front. The shape and firmness of the ball are maintained by the outer tunic. This thick, dense coat is composed of two parts, continuous by their constituent elements, but differing greatly in their physical properties. The one, the sclera, is opaque like tendon; the other, the cornea, is clear like fine glass. The sclera forms a little more than four-fifths, and the cornea the rest, of this strong, investing coat. The *sclera* is thickest posteriorly, where it is pierced by the optic nerve, and reinforced by its outer sheath, measuring here 1 mm. Forwards it grows thinner, till again reinforced by the expanded and laterally blending tendons of the four recti muscles. The sclera is a dense, fibrous, white membrane, composed of fibres of connective tissue, rigidly interwoven in all directions, but running mostly at right angles to each other. The portion seen in front, is called the white of the eye. At the point of penetration of the optic nerve, the sclera is thin and pierced by numerous small holes for the passage of the bundles of optic nerve fibres. This weakened ring of sclera, which plays such an important part in glaucoma, is called the lamina cribrosa. It is that which gives the stippled appearance to the optic papilla, when seen with the aid of the ophthalmoscope. It is situated a trifle below the horizontal meridian, and 4 mm. to the nasal side of the posterior pole. Its diameter is about 1.5 mm.

Fig. 847.

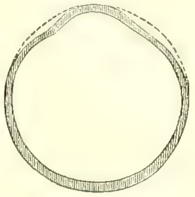


Diagram showing shape of eyeball. (After Merkel.)

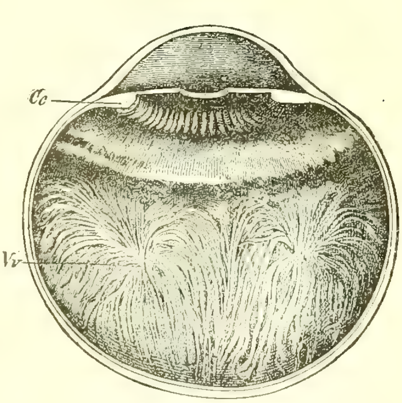
In its entire outer surface, the sclera is embraced by the capsule of Tenon, to which it is loosely connected by elastic tissue, allowing of the greatest freedom of motion. The ball rotates in this capsule, much as the head of the femur moves in the acetabulum.

In front, the sclera encroaches somewhat on the *cornea*, especially above and below. For this reason the cornea appears oval horizontally, when viewed anteriorly, but circular when seen from behind. Near its inner surface, close in front of the iris and just behind the sclero-corneal junction, lies the circular, flattened canal called the sinus venosus, the canal of Schlemm, and, by Leber, the plexus ciliaris. Close in front of this venous canal or canals, the opaque sclera is suddenly transformed into the clear cornea, the line of union being called the limbus corneæ, or the sclero-corneal junction. The horizontal diameter of the cornea, in front, measures 11.6 mm., while the vertical is 11 mm. The anterior surface of the cornea is an ellipsoid, the curvature in the vertical being slightly greater than in the horizontal meridian. This gives rise to a slight degree of normal astigmatism. In the central region, through which direct vision takes place, the anterior and posterior surfaces of the cornea are parallel, the thickness measuring 0.9 mm., while in the periphery it is 1.1 mm. thick. The most important physical properties of the cornea are its great transparency and firmness of texture. It is seldom ruptured by blunt force, the sclera yielding in preference, in a line parallel to and close behind the base of the cornea. In virtue of its epithelial covering, the free surface of the cornea is very polished, reflecting sharp but diminutive images. The conjunctival epithelium is continuous with that of the cornea. As on a basement, this smooth epithelial layer rests on the condensed corneal tissue, called usually Bowman's membrane. Posteriorly the cornea is lined by a "glass" lamella, the membrane of Descemet. Its free surface, washed by aqueous humor, is covered by a single layer of endothelial cells, which have an important bearing on the filtration of fluids through the cornea. The proper tissue making up the main thickness of the cornea, is contained between these two surface membranes, and is of a lamellated character, capable of being resolved into a greater or less number of layers, according to the delicacy of the manipulation. Each lamina is composed of vast numbers of fine elastic fibres, running parallel with each other. The layers are placed upon each other so that the fibres of one lamina will lie at right angles to those of the next. The numerous laminæ are knit together by fibres passing more or less perpendicularly through them. The interspaces between the superimposed layers and their elements are filled with a transparent, gluey substance, in which are lodged the corneal cells, and through which pass the irregular canals that circulate transparent, nutritive fluid. The cornea, as a necessary condition of its great clearness, is non-vascular, only becoming visibly vascular in consequence of inflammation. The cornea, in the deeper layers of its epithelium and in its superficial laminæ, is very freely supplied by a fine, beautiful network of sensory nerve filaments. Its common sensibility is due to this liberal supply from the fifth nerve. The arcus senilis of the cornea, which is seen in many old persons, and rarely in the young, is a fatty degeneration of its elements, in a narrow strip just within its base. The sclera gives solid attachment to the rotatory muscles which reach it by piercing obliquely the capsule of Tenon. The four straight muscles are fixed to the anterior, and the two oblique to the posterior hemisphere of the sclerotic.

Within, the sclera is lined by the *choroid* for about two-thirds of its extent. The two are loosely connected by elastic fibrillar tissue, covered with endothelium, and forming lymph spaces. The choroid is excessively vascular, forming a reservoir of nutritive material for all the inner organs of the globe. It contains, in addition to its exquisite vascularity, fine fibres of connective tissue, numerous cells filled with pigment granules, and many nerve fibres. The amount of pigment in the cells of the stroma varies from great abundance in dark races, to little in fair persons, and none in albinos.

Posteriorly, the choroid is pierced by the optic nerve, the opening corresponding with the optic papilla and the blind spot. The choroid was once considered the seat of visual impressions, and the *hole* in it was, of course, a sufficient explanation for the blind spot! If divided into two layers, the outer contains the large choroidal vessels (vasa vorticosa, etc.) and the inner, the beautiful chorio-capillaris. It is undoubtedly to this rich network of capillaries,

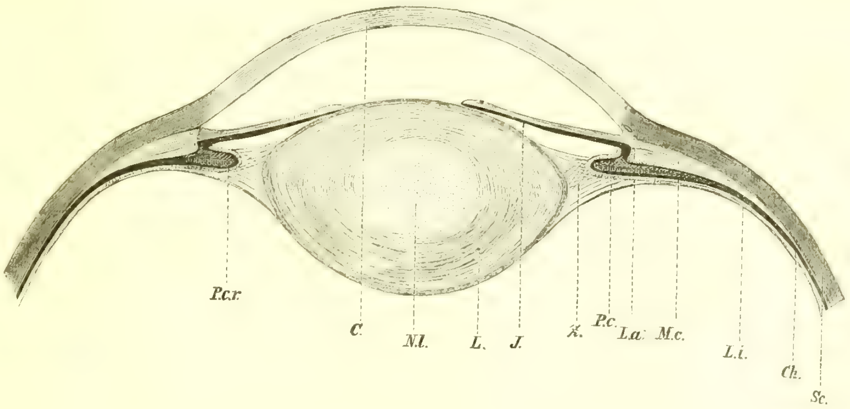
Fig. 848.



Sagittal section of eyeball. × 3. The retina has been removed with the pigment membrane, etc. *Cc.* Ciliary body; *Vv.* Venæ vorticosæ, visible through the inner layer of the choroid. (After Merkel.)

that the outer percipient elements of the retina (the rods and cones) look for their functional nutrition. Anteriorly, the choroid thickens into a wedge-shaped portion, called the *ciliary body.* From the ora serrata retinæ to within 1 mm. of the sclero-corneal junction, the thickness gradually increases, terminating in the ciliary processes, which surround the margin of the crystalline lens without touching it. The processes are about seventy in number, and make a beautiful picture when the eye is divided through the equator and they are looked at from behind. A good idea of them and of the vasa vorticosa is obtained from Fig. 848. Continuous with the ciliary processes, and gaining from them part of its peripheral insertion, is the iris. Passing from the points of the ciliary processes to the margin of the lens, is the folded zone of Zinn, or suspensory ligament. The lens, agglutinated to the hyaloid fossa of the vitreous, and fastened by this ligament to the ciliary processes, makes a complete septum between the vitreous behind and the aqueous in front. (Fig. 849.)

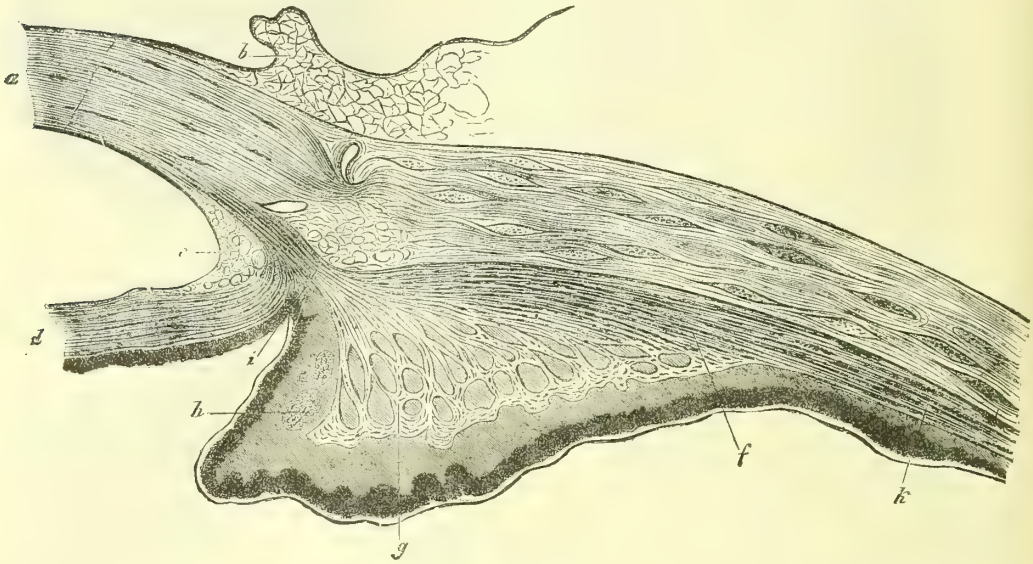
Fig. 849.



Meridional section of anterior half of human eyeball. *Sc.* Sclerotic; *Ch.* Choroid; *L.i.* Internal limiting membrane; *M.c.* Ciliary muscle; *L.a.* Annular ligament; *P.c.* Ciliary processes; *Z.* Ciliary zone; *L* Iris; *L.* Lens; *N.l.* Nucleus of lens; *C.* Cornea; *P.c.r.* Ciliary portion of the retina. × 4. (After Gerlach.)

On the outer surface of the ciliary body, next the sclera, lies a thickened, grayish ring, from 3 to 4 mm. wide—the *ciliary muscle*—by the action of which, on the lens, the eye is focused for distinct vision at different distances. This muscle takes its fixed attachment from the inner surface of the sclera, in a circular, tendinous ring, corresponding to the inner wall of the canal of Schlemm (Fig. 850). From this attachment it sends some tendinous fibres to the iris, and large numbers to the radiating and circular, non-striated fibres of the ciliary muscle. This muscle, acting from the sclero-corneal junction, draws the choroid forwards and renders it tense, moving the ciliary processes likewise forwards, and a little towards the axis of vision. Thus the suspensory ligament is relaxed, and the anterior surface of the lens, which is compressed in the quiescent state of the muscle, is allowed to grow more convex, in response to its natural elasticity. It is thus that the eye is accommodated for near vision, by an active process, producing *relaxation.*

Fig. 850.



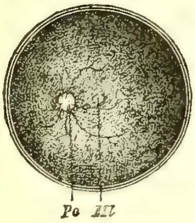
The ciliary muscle. *a.* Cornea; *b.* Limbus corneæ; *c.* Sclerotic; *d.* Iris; *e.* Space of Fontana; *f.* Meridional portion of ciliary muscle; *g,* Radial portion of the same; *h.* Annular muscle of Müller; *i.* Anterior tendon of ciliary muscle; *k.* Posterior tendon of meridional portion of same. (After Iwanoff and Arnold.)

The active, muscular curtain, which regulates the amount of light admitted to the eye, the *iris,* is fastened at its periphery by fibres from the ligamentum annulare of the ciliary muscle, by bloodvessels passing directly between it and the choroid, and by the ligamentum pectinatum—bands of elastic fibres thrown over from the membrane of Descemet to the iris, at the outer margin of the anterior chamber. The spaces between these trabeculæ, and connecting with the aqueous chamber, allowing perhaps free filtration of the intraocular fluids, are now called Fontana's spaces.

In the surgical pathology of the eye, the ciliary region, including the outer rim of the anterior chamber, plays a very important part. The iris is a membranous septum, circular in form, passing across the eye close in front of the lens, from its attachment, 1 mm. behind the clear margin of the cornea, and pierced in its centre by the pupil. Its tissue is delicate, easily torn, and very sensitive, and both surfaces are bathed with the aqueous humor, in which it moves with perfect freedom. In its stroma are two antagonistic sets of muscular fibres. One set is arranged in a circular band around the pupil, on the posterior surface, and about 1 mm. wide, supplied with motor force by filaments from the third nerve. The other muscle passes from the entire periphery of the iris, in converging directions, to the sphincter pupillæ, with which its fibres are interlaced. This is the dilator of the pupil, and it is endowed by filaments from the sympathetic nerve. The iris tissue is abundantly supplied with bloodvessels and pigment cells, the latter more exuberant on the posterior surface. There is likewise a generous distribution of nerve-fibres, sensory and motor, all the elements being united by connective tissue. The iris, in a narrow ring around the pupillary border, rests against the anterior lens capsule, over which it slides in the almost constant movements of contraction and dilatation of the pupil. The pupil moves in response to reflex impressions, made by light on the retina.

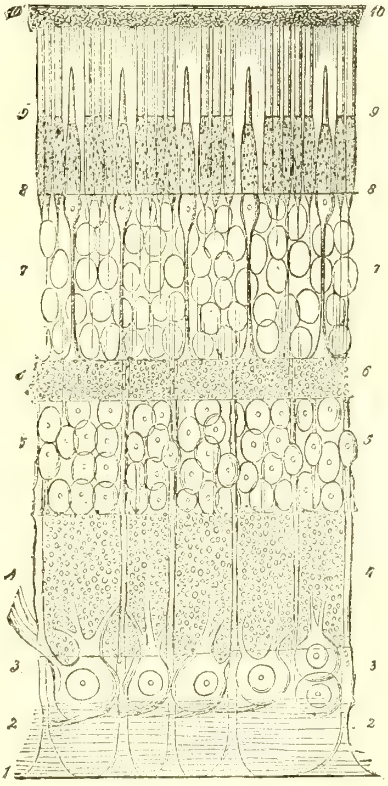
Lying immediately within the choroid, and extending from the optic nerve entrance to the ora serrata retinæ, is the nerve-membrane, the *retina*. It is a very soft, perishable structure, quite transparent, and hence invisible, except by the bloodvessels with which it is freely supplied. Ordinarily perfectly colorless, it becomes of a purplish-red by a sojourn in the dark. This color is soon dissipated when the eye is exposed to common light. Fascinating as may be the chemical theory of vision, it is by no means certain that actinic action has anything to do with this marvellous function. Three objects, all in or connected with the retina, are positively to be seen by ophthalmoscopic illumination: the optic disk, with its sharp margins and characteristic vessels; the *macula lutea*, in the direct line of vision; and the ramifications of the retinal vessels. The disk or papilla is of circular form, 1.4 mm. in diameter, light purplish-white in tint, and contrasting sharply with the deep-red color of the rest of the fundus of the eye. In its centre are seen the main trunks of the central artery and corresponding veins of the retina, radiating and ramifying in all directions, but more notably towards the inner, upper, and lower parts of that membrane. The arteries are easily distinguished by their lighter color and somewhat smaller size. About 4 mm. from the centre of the papilla, and outwards, is seen the macula lutea with its fovea centralis. This lies in the axis of direct vision, and is the most exquisite part of the retina. (Fig. 851.)

Fig. 851.



Equatorial section of eyeball, natural size, posterior segment. *Po.* Optic papilla; *Ml.* Macula lutea. (After Merkel.)

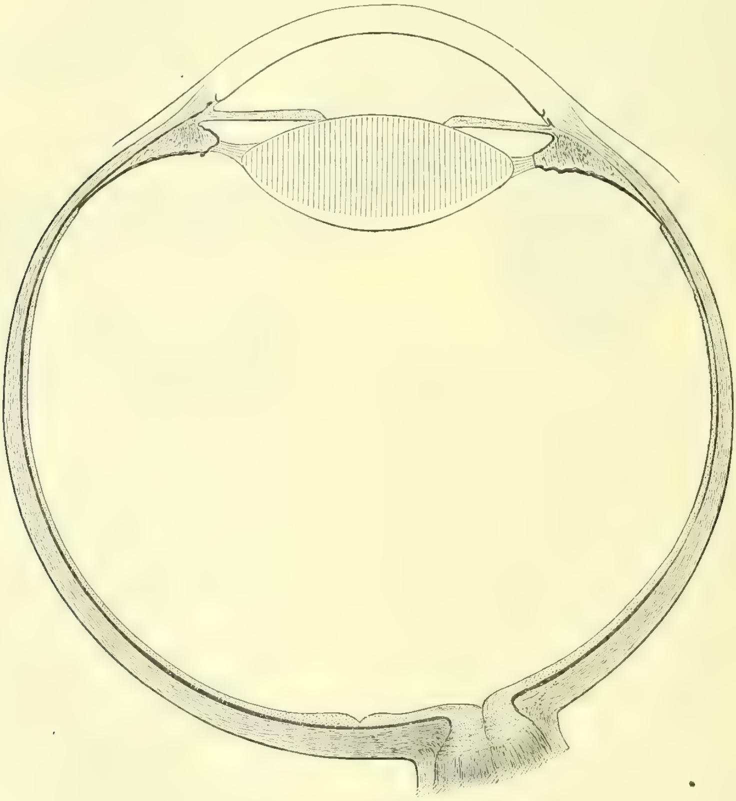
Fig. 852.



Diagrammatic section of the human retina, showing its ten layers. (After Schultze and Schwalbe.)

The conducting fibres of the optic nerve, estimated at 438,000, unfolding in the papilla, bend suddenly outwards and are lost in the retina, constituting its innermost layer, in which are distributed the arteries and veins. Studied in microscopic sections, there are ten distinct layers in the thickness of the retina. (Fig. 852.) The tenth of these, the pigment epithelium, formerly described as belonging to the choroid, and in which are buried the outer ends of the rods and cones, is now known to be an integral and very important part of the retina. The rods and cones standing perpendicularly in the outer layer of the retina, are the percipient elements; the inner layer is composed of nerve-fibres which are conductors; and the intermediate structures serve to connect these two essential elements. Filling and giving solidity to the globe of the eye, and with the cornea forming its refracting media, are the aqueous and vitreous humors with the crystalline lens between them. (Fig. 853.)

Fig. 853.



Diagrammatic horizontal section of the eye. (After Merkel.)

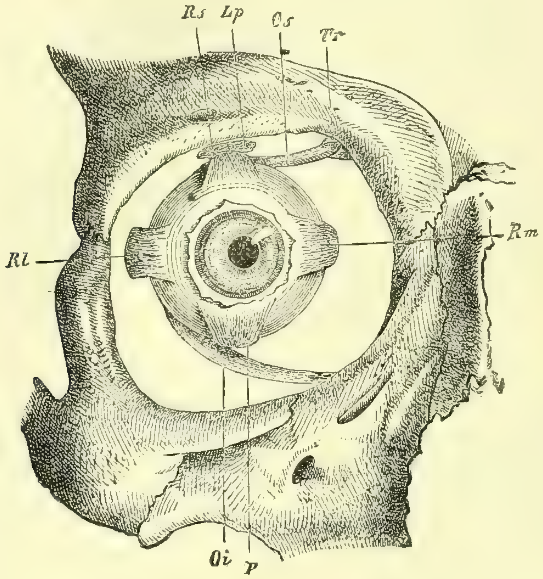
The space between the cornea and the lens is the *aqueous chamber*, divided by the iris into the anterior and posterior, communicating through the pupil. The depth of the anterior chamber is 3.6 mm. In active accommodation, the lens capsule, becoming more convex and carrying the iris forwards, diminishes slightly the depth of the chamber. It is now positively certain that the *lens*, acted on by the ciliary muscle, is the *instrument* of accommodation. As age progresses the lens hardens, responding less and less to the efforts of this muscle, and the patient becomes presbyopic and has to use glasses for reading, except when myopic.

The popular notion that flattening of the cornea is the cause of presbyopia has no foundation. The lens is a double convex body, held in its position close behind the iris, by the suspensory ligament and adhesions of its posterior capsule with the hyaloid fossa. In young persons it is soft, elastic, and colorless; in advanced years it becomes of an amber color, and hard like a piece of dry cheese. The anterior surface of the lens is less convex than the posterior. The thickness of the lens in its axis is 3.7 mm., and its equatorial diameter is from 9 to 10 mm. The firmer, central part of the lens is called the nucleus, and the outer layers the cortical substance. It is composed of numerous layers like an onion, the layers being formed by individual, serrated lens-fibres. The lens is closely invested by a capsule, of which the anterior portion is thicker and more resistant than the posterior. It is structureless and perfectly clear, and resists chemical reagents in a remarkable way. The medium of connection between the lens and the capsule is a thin layer of cells from which the lens-fibres take their origin, and through which its nutrition is accomplished. How the lens is held in its position has been already stated.

Filling up all the interior of the eye, back of the lens, is the *vitreous humor*, or corpus vitreum. This is of the consistence of jelly, hangs together in a mass when lifted, and is absolutely transparent. Hence the difficulty in studying its structure, and the various views in regard to it, error being sometimes caused by the chemical reagents used in hardening it. Liquefaction of the vitreous takes place soon after death, and, in many pathological conditions, during life. In the extraction of cataract, a healthy vitreous greatly diminishes the risks of accident, and should be ascertained as certainly as possible. In the process of diseases of the choroid, especially, the vitreous is liable to become in part or entirely disorganized. In that case it is turbid, with floating corpuscles, and interferes with satisfactory ophthalmoscopic examination.

MUSCLES ATTACHED TO THE EYEBALL.—The eyeball, so balanced in the orbit as to yield to the least muscular force, is rotated in the various directions by six muscles. The four recti, originating by a common tendon at the optic foramen, passing directly forwards so as to embrace the globe and fasten themselves upon it, form two pairs. The superior and inferior oblique constitute the third pair. The favorable way in which the eye is pivoted in the socket, and acted on by these muscles, is well seen in Fig. 854. Of the four recti, the internal is the strongest and the superior the weakest. Before their firm insertion into the sclera, the four recti become tendinous, the width and situation of their insertions being easily seen in the cut. The flattened tendons, the relative distance of their insertions from the cornea, and the peculiar relations of the tendons to the capsule of Tenon, through which they must pass to reach the sclerotic, have been very critically studied since the introduction of tenotomy for the relief of squint. The most trustworthy measurements (Merkel) of their points of attachment from the cornea, are: for the rectus internus 6.5 mm., rectus externus 6.8 mm., rectus superior 8.0 mm., rectus inferior 7.2 mm. The width of the tendons varies from 7 mm. to 9 mm. These tendons, before their insertions, send numerous filaments of connective tissue to the sclera, and also from their edges, thus adding firmness and breadth to their proper tendinous attachments. The globe is embraced by the capsule of Tenon, which is loosely connected to the sclera, and in which the eye rotates. It blends with the conjunctiva, and ends near the margin of the cornea. Behind, it is connected with the ball at the seat of penetration of the ciliary nerves and vessels, not reaching quite to the optic nerve. Coming forward through the cushion of orbital fat, the recti muscles pierce this capsule obliquely by their tendons, and are loosely connected with it. The fascia of these muscles is likewise pretty firmly

Fig. 854.



The eye in its normal situation in the orbit, seen from in front. *Lp.* Levator palpebræ superioris ; *Rs, Rl, Ri, Rm.* Attachments of the straight muscles of the eyeball. *Tr.* Trochlea. *Os.* Tendon of the superior oblique muscle. *Oi.* Inferior oblique muscle. (After Merkel.)

connected to the outer surface of the capsule of Tenon, where they press upon it before passing through to reach the sclera. It is this arrangement that prevents a complete tenotomy from destroying all control of the muscle over the eye. It still rotates the eye through this indirect influence on the capsule and its insertion around the cornea.

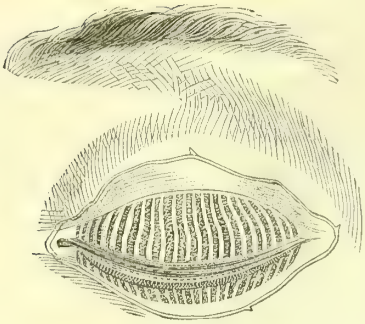
The movements produced by the isolated or combined action of these muscles, are rotations around a fixed point in the axis of vision, 13.54 mm. behind the centre of the cornea, near the physical centre of the globe. In moving the eyes right or left, in the horizontal level, one muscle only in each eye is called into play. The external moves the cornea directly outwards, and the internal, inwards. In moving the cornea directly upwards, the superior rectus and inferior oblique combine in their action. In turning the cornea downwards, the inferior rectus and superior oblique work together. In all the oblique movements of the eyes, three muscles combine. In all movements *below* the horizontal level of the eyes, the superior oblique is brought into play. In all rotations *upwards*, the inferior oblique is active. The single action of the superior oblique rotates the cornea downwards and outwards, that of the inferior oblique upwards and outwards. The third nerve (oculo-motor) supplies the recti muscles (except the external), the inferior oblique, and the levator palpebræ superioris. The fourth (trochlearis) inspires the superior oblique, and the sixth the external rectus.

In no other part of the body do we so readily detect even slight muscular disturbances, as in the rotatory movements of the eyes. Derangements that elsewhere would never be noticed, are here painfully forced on the attention by diplopia, or double vision. This is present no doubt in the beginning of all cases of strabismus, and is the most harassing and persistent symptom of muscular paralysis.

Eyelids and Lachrymal Apparatus.—That the movements of the eye may meet with the least possible resistance from friction, the anterior half of the globe and the inner surface of the lids are lined by a smooth mucous membrane, constantly lubricated by its own secretions. To provide additional moisture, and keep the cornea constantly free from accumulations of the waste epithelium, the secretions of the *lachrymal gland* come into play. This gland lies in the pit near the upper and outer margin of the orbit, and pours its fluid through the excretory ducts on the eyeball. The surplus tears find their way over the globe, and are finally carried into the nose by the tear passages, the canaliculi, the lachrymal sac, and the nasal duct. The *conjunctiva* extends from the free edges of the lids, where it is continuous with the skin, back through the fornix to the globe, and thence forwards, over the sclera, to the margin of the cornea, the latter being covered by the continuous epithelium. It is divided, according to its distribution, into the tarsal portion; the reflected portion, or fornix; and the ocular portion that covers the sclera. The tarsal division is firmly united to the inner surfaces of the tarsi, above and below, and is dissected off with difficulty. The reflected portion is more loosely united to the structures below, and readily becomes infiltrated by inflammatory products collecting in, and especially underneath it. The ocular covering is very thin and transparent, and is also connected to the sclera very loosely. Inflammatory collections under it, so common and so alarming, are called chemosis. At the margin of the cornea, the conjunctiva, blended with the capsule of Tenon, is firmly united to the sclera. Hence, to effectually fix the eye for surgical operations, it must be seized as close to the cornea as possible. The free, smooth, epithelial covering of the conjunctiva, forms the surfaces that glide so easily and comfortably over each other in the movements of the eyes, and in winking. The conjunctiva, especially the strip lining the back portion of the tarsus, next the fornix, is traversed by many deep fissures which communicate freely, and into which the epithelium dips, giving it an uneven appearance. These fissures were formerly described as papillæ. The conjunctiva is supplied with bloodvessels, and parts are infiltrated with lymph cells, capable of enormous increase, and causing great swelling and hypertrophy in inflammation. It is likewise freely endowed with sensibility by distributions of the fifth pair. The different kinds of glands that open on the conjunctiva, along the free margin of the lids, on the limbus conjunctivæ, and in the fornix, properly belong to other structures of the lid.

The *eyelids* are movable, complicated structures, opening and closing in response to muscles, like shutters. Into the framework of each, to give it stiffness, enters a condensed fibrous structure of semilunar shape, called the tarsus. The tarsus of the upper lid is longer and broader than that of the lower. The thick, sharp-cut edges of the lid, along the anterior lip of which the eye-lashes are implanted, and on the posterior lip of which the Meibomian ducts are seen, is formed chiefly by the thick tarsus. Toward the upper edge, into which the levator palpebræ superioris is fastened, it grows quite thin. Imbedded in the thickness of the tarsus, perpendicular to its free margin, and belonging histologically to the skin, are the Meibomian glands, long tubes with acinous attachments, and opening in visible points along the inner lip next the conjunctiva. (Fig. 855.) The points in which the two lids unite are called commissures. The outer commissure is sharp, and the inner rounded out to receive the caruncula lachrymalis of the conjunctiva, behind which is a vertical, thickened fold of conjunctiva called the plica semilunaris. At the inner com-

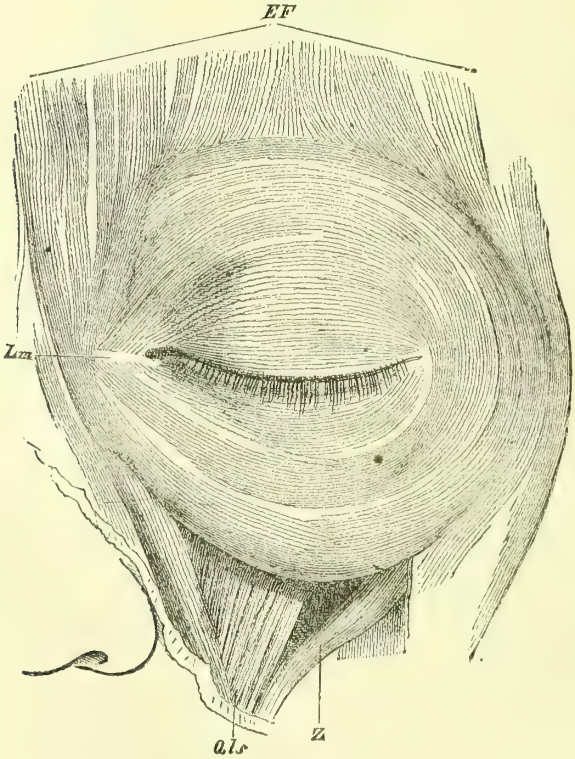
Fig. 855.



The eyelids closed. The skin over both tarsal cartilages removed, so as to make the tarsal glands visible. (After Merkel.)

missure are also found the tear ducts for collecting and carrying off the superfluous tears to the nose. At the inner end of each tarsus are the openings of the canaliculi, one above and one below. These points, surrounded by some circularly disposed fibres of the orbicularis muscle, are called the puncta lachrymalia. The small canals leading from them into the lachrymal sac, are the canaliculi. They sometimes unite before reaching the sac, and at other times enter it separately. Lying in the lachrymal groove of the os unguis, traversed near its middle and supported by the tendo oculi of the orbicularis muscle, is the lachrymal sac, which passes by the nasal duct to the inferior meatus of the nose. In a healthy state the

Fig. 856.



Orbicularis muscle of the left eye, with the neighboring muscles. *Lm.* Median palpebral ligament; *E F.* Occipito-frontalis muscle; *Qls.* Quadratus labii superioris; *Z.* Zygomaticus. (After Merkel.)

puncta are held gently against the ball, and the tear passages are made to perform their function by the action of the orbicularis muscle. Through the puncta, the mucous lining of the eyelids is continuous with that of the nose and throat. Lying on the anterior surface of the eyelids, between the skin and the tarsi, and extending over the prominent base of the orbit, is the sphincter of the eyelids, the orbicularis muscle. Beginning from the lower edge of the tendo oculi and the adjacent bone, it sweeps around the outer commissure and comes back to be inserted into the upper edge of the same tendon. It is divided into the palpebral portion, lying on the tarsi and exclusively used in winking, and the orbital, called into voluntary play when the eyes are firmly closed. This muscle is supplied by the portio dura of the seventh pair, and, with its relations, is beautifully seen in Fig. 856. Implanted deeply along the anterior lip of the free margin of the lid, with their bulbs between the orbicularis fibres and the surface of the tarsus, are the ciliæ or eye-lashes. Covering the entire muscle and continuous with the skin of the face, is the thin cutaneous covering of the eyelids, with its loose subcutaneous tissue. The upper eyelid is provided with a muscle, the levator, to lift it, while the lower subsides over the projecting globe in response to gravitation, when the orbicularis is relaxed.

Optical Defects dependent upon Anatomical Peculiarities of the Eye.—By actual measurement the eye varies in size very much, in different persons. The optically perfect eye measures 24 mm. in the antero-posterior diameter, and is called *emmetropic* or normal. In such an eye the retina lies in the focus for parallel rays. Distant objects, from which such rays only come, are sharply imaged upon the retina. By distant, we mean from 18 feet off to infinitely far, as the stars. If the eye is smaller than this ideal standard, measuring, for instance, 20 mm. from cornea to retina, it is called *hyperopic*. In that case parallel rays, undergoing the same refraction by the cornea and lens, will strike the retina *before* intersecting, and the image will not be sharp. Hence vision of remote objects is imperfect, as long as no voluntary muscular effort of accommodation is added. Theoretically, such an eye could only unite *convergent* rays upon the retina; but in nature no objects exist that send off such rays, because none are *beyond* an infinite distance. Practically, then, such eyes are always on a strain, making active efforts of accommodation for all distances. They are never at rest except in sleep. By an emmetropic eye, remote objects are seen with perfect definition without any accommodative muscular action. Hence the ciliary muscle is at absolute rest, except in reading and near work. This difference accounts for the tired and fatigued feeling of hyperopic eyes, which distresses them and gives the physician so much trouble and anxiety. When applied to close work especially, they tire easily, and are called weak or asthenopic. The pain and fatigue result from strain of the ciliary muscle, and the trouble is called accommodative asthenopia. It is in hyperopes that we so often find convergent strabismus. There is still another deviation from the emmetropic form, and that is the *myopic* or near-sighted eye. In such the distance from cornea to retina is increased, so that parallel rays intersect *before* reaching the nerve membrane. The axis of vision measures 25, 30, or even more, millimetres. The farthest point of distinct vision, instead of being at an infinite, is at a finite distance. It comes nearer and nearer, as the degree of myopia increases. Beyond the far point, all is dim, the farther the worse. Such eyes can only get sharp images of distant objects by the use of concave lenses. All persons who see distant objects *better* with convex lenses, *must* be hyperopic. Those whose remote vision is cleared by concave glasses, *may* be myopic. Myopia occurs rarely in old people, and then generally with incipient cataract. If the myopia reaches in them a high degree, they lay aside their spectacles for reading and boast of second sight. Just in proportion as they gain in reading without glasses, they lose in distinctness of sight for distance, and must use concaves. Myopia is an *acquired disease.* Hyperopia is a *congenital defect.* In myopia the eyeball is enlarged and strikingly prominent. Around the posterior pole the sclera and other tunics bulge backwards, giving that part of the globe an egg shape. Diagnosis of the refraction of the eye is not always easy. In expert hands, the most direct and independent means of ascertaining the refraction is the ophthalmoscope. But accuracy in this means of diagnosis involves not only a long experience, but an absolute knowledge of the refraction of the observer's own eye. If the eye of the examiner and that of the examined are both emmetropic, then an absolutely sharp image of the fine vessels in the direct fundus will be obtained. To do this and get a large magnifying power, the eye carrying the ophthalmoscope must approach almost to contact with that inspected. This is the examination in the erect image. If the examiner's eye is myopic, or hyperopic, it must be rendered emmetropic by the proper lens in the eye-clip.

If no distinct image of the fine fundus is obtainable, the accommodation of the examiner and examined being relaxed, then there is *either* hyperopia or myopia. If a convex lens added to the clip makes the details clear, there is hyperopia. If a concave is required, it must be myopia. In the family of mydriatics we find a valuable aid in ophthalmoscopic diagnosis. When atropine, hyosciamine, or duboisia in strong solution, is applied to the eye, it soon dilates the pupil and paralyzes the ciliary muscle. By this means we eliminate a troublesome factor, the accommodation, and have the eye at rest. Moreover, when the accommodation is relaxed in this way, it renders the use of test-glasses in the diagnosis very easy, simple, and sure. Atropinize a myope, and it will affect his distant vision little or none. It was bad before, and is so still. Do the same for an emmetrope, and his remote vision will not be seriously changed. It was good before, and is so still. The only change is, that he can no longer read print without the aid of a strong convex lens. His power of varying the refraction, by voluntary contraction of the ciliary muscle, is temporarily lost. Subject a hyperope to the thorough action of atropine, and his sight for distance will be reduced, more or less seriously, according to the degree of hyperopia. Then, if a convex glass brings it up to what it was before, hyperopia undoubtedly exists, and the *degree* is measured by the strength of the glass required to give perfect sight for distance. This is the most certain means of diagnosis, and in all doubtful cases should be resorted to in order to confirm the diagnosis by other methods. One serious objection to the use of the ordinary salts of atropia for this purpose, as well as for facilitating ophthalmoscopic examinations, is the long time (sometimes a week or more) that the effects last. Happily, the homatropine relaxes the ciliary muscle quickly and thoroughly, and its effect soon passes away, generally inside of 24 hours. To do this thoroughly it must be strong (8 grains to the ounce), and dropped in freely every 20 or 30 minutes, for two or three times. No constitutional effects are noticed, as in the similar use of atropine or duboisia. Duboisia is quite as certain in its effects, and more transient than atropine. Its influence does not pass off as soon as that of homatropine, and it is very liable to produce serious constitutional symptoms. I now use homatropine almost exclusively for testing refraction and for ophthalmoscopic examinations; in the latter, applying a much weaker preparation. Hyperopia may be entirely latent, or altogether manifest. In the former case, it is neutralized by the strong activity of the ciliary muscles, as in children and young people. In the latter, nearly always in persons in advanced life, the lens becomes so hardened that the ciliary muscle can no longer overcome the hyperopia. When the hyperopia is all manifest, the simple use of the mirror and of the test-glasses is all that is required. In that condition hyperopes are compelled to use glasses all the time, or else to see very imperfectly. They need one pair to neutralize the hyperopia and to walk with, and another, stronger pair to read with. Young hyperopes, whose eyes have been trained to tolerate the glasses they need, can use the same glasses for walking and reading. Their accommodation makes up for the increased refraction needed in reading. Another anomaly of refraction is often found, alone, or in connection with hyperopia or myopia. It is due to differences of curvature in the different meridians of the cornea, and is called *astigmatism.* As in other anomalies, the refraction may be defective or excessive, constituting hyperopic or myopic astigmatism. Astigmatism in high degrees impairs the sight much more than simple hyperopia or myopia, as the effect is very imperfectly corrected by accommodation. The diagnostic aids are the ophthalmoscope, mydriatics, and tests with glasses of cylindrical surface, convex and concave. The usual test-types, as in trying for hyperopia and myopia, a system of lines radiating from a centre, and other devices, are resorted to in order to facilitate accuracy of diagnosis. My space will not allow details in this interesting department of physiological optics.

DIAGNOSIS OF OCULAR AFFECTIONS WITHOUT THE USE OF THE OPHTHALMOSCOPE.

Medical men often talk flippantly about the use of the ophthalmoscope, flourishing the instrument before the dazed eyes of their patients, seeing *nothing* and not even knowing how to interpret *that.* It is kept as one of many professional trappings, and has its reward. As a blow-bugle, in the recruiting office of rival medical schools, it has an important place, but how few students ever look through it with discrimination! A few weeks of special instruction by a competent teacher will alone enable the student to *begin* the intelligent employment of it in diagnosis. But daily and persevering use of this or any other instrument of precision, is required to give it serious importance. I do not exaggerate its difficulities, or disparage its faithful employment. It is invaluable in the differential diagnosis of deep-seated lesions of the eye, as well as in the study of disease seated elsewhere. It would be as rational to study astronomy by the aid of a spy-glass when we can use a telescope, as to discard the ophthalmoscope in the critical study of fundamental diseases of the eye. But I simply state the above well-known facts, in order to urge the importance of other and simpler means of diagnosis, which are too much neglected by the general practitioner. I want to show how many valuable things he can find out by the aid of the spy-glass!

Cataract, when bad enough to seriously trouble sight, can be perfectly made out without the ophthalmoscope. With the pupil dilated and oblique illumination, no doubt need exist. Then the functional tests will show whether the visual defect is in rational proportion to the changes seen in the lens. Is the cataract mature, and the propriety of an operation asked? Functional interrogation of the retina as to acuteness of perception, and the visual field, is easily made and satisfactory. *Glaucoma*, frequent in senile subjects, may be fatally mistaken for cataract. And yet no very great tact is required to settle the differentiation without the use of the eye mirror. The absence of definable opacities in the lens; careful and repeated tests of tension; the general outward appearance of the eye, including the episcleral circulation; the size of the pupil, its activity and the texture of the iris; and above all, trials of visual acuity and the integrity of the field, will settle the question. Simple cataract runs its entire course without pain. Glaucoma seldom does. Indeed, in the worst cases of acute glaucoma, the vitreous is so turbid and the cornea so dull, that no ophthalmoscopic inspection of the fundus is possible. Yet our diagnosis need be none the less positive.

Iritis in all forms and degrees can be made out, beyond a doubt, by ordinary scrutiny, aided by atropine and oblique illumination. If cyclitis, or choroiditis, or optic neuritis exist with it, the eye is usually too tender to light, even if the vitreous be clear, to admit of a protracted use of the reflector. The functional tests of vision, in a moderate light, will give a reasonable clue to the integrity of the fundus. If the defect of sight be out of proportion to the changes in the iris, pupil, and aqueous humor, we infer a deep-seated complication. Increased tension in such a case means *glaucoma*, and the reverse indicates *cyclitis.*

Of course, all alterations of transparency and shape in. the *cornea* are perfectly ascertained by the usual means, oblique illumination and functional tests of vision. There is no excuse for mistaken diagnosis between these and cataract, and the ophthalmoscope *alone* is very liable to lead to error.

How many hundreds of patients are referred to specialists for "disease of the optic nerve," where the fundus is absolutely sound, and where a rational diagnosis might and should have been made without the mirror! These are cases of *asthenopia*, with very characteristic symptoms. Painful fatigue of eyes, blurring of vision and difficulty in reading after a few moments' close application, heaviness of the lids and frequent desire to close and rub them, are the most constant burden of complaint. The sufferings are always aggravated by persistent, close use of the eyes, sedentary habits, nervous temperament, anæmia, and the multiform manifestations of hysteria. People thus affected are usually still young in years, but old in complaints. In females, it is very apt to be an accompaniment of uterine disturbances, and increased by causes of debility. The patient has been a victim of these painful troubles and forebodings, perhaps, for many years, and still has perfect sight when briefly tried. For a few seconds he reads the finest print, and has perfect definition for distance, but then the sight wavers. How can a serious lesion of the optic nerve, or of any other important part of the eye, persist so long, give so much pain and worry, and still leave the sight perfect? Real diseases of the optic nerve, in their entire course to total blindness, are attended by little or no pain. This is true of many of the worst diseases of the retina and the choroid. Let us look into some of these cases by common aids, and guided by a modicum of mother wit. Outwardly the eyes look healthy. Tested separately, the sight of the two eyes is equal and perfect for distance. The patient reads the smallest diamond type distinctly for a few moments. Then the letters mix, blur, and the eyes become painful. So he desists, and closes and rubs his eyes. There is probably some anomaly of refraction, producing fatigue of accommodation. Convex glasses, one dioptric (37 inches focus) clear the print and enable him to read longer without fatigue and glimmering. He cannot be myopic, but may be, probably is, hyperopic. Further investigation must now be made to settle that question. But of this you may be certain. The patient has no disease of the optic nerve, nor other affection that is going to lead to blindness. You can set his mind at rest on that point. If distant vision is imperfect, and near work quite clear, he may be myopic, and the necessary investigation should be made. If in any case, the sight of the two eyes is materially different, they must be examined separately, and the vision equalized if possible. If the vision is very bad in one, and perfect or nearly so in the other, then there may have been a congenital difference, or one of long standing, but just now found out. If both eyes are bad for all distances, then there may be a marked astigmatism or other trouble requiring the ophthalmoscope and means of investigation not at your command. Whether it is a disease requiring treatment, or an optical defect demanding assistance from glasses, can only be settled by an expert examination. These asthenopic troubles that give the surgeon and the patient so much anxiety, depending as they do upon so many different causes, cannot be fully investigated or satisfactorily treated by the general surgeon.

Patients sometimes apply for advice about the alleged sudden failure of the sight in one eye. It has usually been discovered by the merest accident. The patient insists that he retired with two good eyes, and arose with one blind. How do you know that the patient is mistaken? If he has a matured cataract, or confirmed glaucoma, or old alterations of the cornea, none of these could have developed in so short a time. If there is strabismus confined to the defective eye, it cannot be of sudden origin. If the bad sight dates from childhood, or has come on very slowly, without pain, inflammation, or any unusual subjective symptom, it often passes unnoticed, till by some mere accident the patient is led to try the two eyes separately. If some confusion of vision, pain, or other uncommon worriment, such as flashes of light, glimmering, etc., have prompted him to the test of the two eyes, the difficulty is probably recent, and needs immediate intelligent attention. The previous history and habits of the patient as to shooting, and with which eye and what success, may also assist in clearing up the date of the difficulty. Has the eye ever been injured, and, if so, in what way and when? Has he ever used an opera glass with satisfaction? Without binocular vision that instrument is of little benefit. If the defect is very old, particularly if congenital, the ophthalmoscope, even in expert hands, is often simply negative in its findings. But when the lesion is serious and of recent date, it is often quite possible to make a fair diagnosis without the instrument. Suppose the patient to have had good eyes till quite lately. All at once he sees flashes of light, glimmering, trembling in the air like heat, and confusion of sight. He tries separately, and finds which eye is at fault. These troubles continue, with variations, for a few days. Then he discovers a dark curtain drawing in front of the eye. It passes across from one side to the other, cutting off all sight except perhaps in one oblique direction. With this significant description, you ask him to close the eye gently. You place the two index fingers on the ball and find its tension much reduced. The fatal diagnosis is *detachment of the retina*. If the patient has long been very near-sighted, this conclusion is greatly strengthened.

Again, there may have been great and sudden failure in one eye, perhaps without any premonitions, or these may have been very brief. The patient is advanced in years, has often suffered from rheumatism, and actually has organic lesion of the heart. The arteries feel hard to the finger, indicative of atheromatous degeneration. While coughing, lifting, straining at stool, in a violent fit of anger, or even without any special provocation, a large, red, ragged cloud comes before the eye. Here is a case of *hemorrhage into the vitreous*, from bursting of an intra-ocular vessel, a very serious affair for the eye, and still more grave as a prophetic indication of a similar accident to the brain. Spontaneous rupture, even of a subconjunctival vessel producing a blood-shot eye, is of no consequence in itself, except as it takes place in advanced years; and then it means brittle arteries, and danger to the brain or other vital organ.

Once more, you are consulted by a woman advanced in pregnancy. More or less rapid failure of sight in one or both eyes has brought her to you. You find vision generally impaired, especially in the direct line, by a central cloud or scotoma. Some pain and photopsia have been felt and seen, but outwardly the eyes appear normal. You suspect *Bright's disease*, and an analysis of the urine confirms your suspicion. The patient has albuminuric retinitis, with changes so peculiar and characteristic, when seen with the ophthalmoscope, that the diagnosis of renal disease can be made from them alone. Still, we can be reasonably certain of the true lesion without using the ophthalmoscope. These eye symptoms, in a case of pregnancy, should lead us to expect puerperal convulsions before or at confinement.

Again, a patient with perhaps a syphilitic or rheumatic history, complains of double vision. This may or may not have followed headaches and other evidences of brain disturbance. It may have come from a current of air, or from no appreciable cause. He is giddy and uncertain in his gait. The moment one eye is shut, the diplopia ceases, and he sees without confusion. In closing one eye and walking across the room, his head swims and he staggers. Let him now shut that eye and walk with the other open. He feels secure and steady. He has *paralysis* of some one of the six *rotatory muscles*, and the *lame* eye is the one which he cannot walk with. Further investigation will differentiate the implicated muscle.

Another patient, a youth, has had excruciating attacks of headache, accompanied by vomiting. These paroxysms have lasted for months. They come suddenly, even when he is eating his dinner, and quickly he vomits his food and is relieved. He may eat again at once. This is causeless vomiting, not preceded by protracted nausea, but by violent pain in the head. At length dimness of vision begins in both eyes. The pupils are dilated, and there is a vague stare in the expression. This is a case of double *optic neuritis* from central brain lesion, probably *a tumor.* Of course the prognosis is very grave, both for sight and for life.

A child is brought, with supposed cataract in one eye. Your attention is attracted at once to a peculiar, yellowish, copper-colored reflex from the pupil. You see that it is too deep in the eye for cataract, and that it has not the color of an opaque lens. Otherwise the eye looks well. There is no pain as yet, and the little victim perhaps still sees somewhat with it. Diagnosis: *glioma*, or rather *sarcoma*, of the retina; and prognosis: death in a few months.

A person more advanced in years, has complained at intervals, for a long time, of pain, injection of the eye, and failing sight. At first he detects a circumscribed defect of vision in a certain limited portion of the field. Slowly the blind region enlarges, and the pain increases in frequency and severity till, at last, the blind eye is intensely painful all the time. Tension is increased; ciliary injection is marked; and large, tortuous, and inosculating vessels are seen in loops around the cornea. The pupil is excessively dilated; the anterior chamber very shallow; the iris discolored and its tissue greatly atrophied. This is probably a case of secondary glaucoma coming from a sarcoma or other *tumor of the choroid.* A similar growth in the *ciliary body* would be seen distinctly behind one edge of the lens, pushing it and the iris forwards.

A female, up in years and probably unmarried, consults you for excessive nervousness. Her eyes are protruded. Her expression is anxious. She gets scared and "flies all to pieces" at nothing. Her pulse runs from 120 to 140, feeble and irregular. There is more or less enlargement of the thyroid gland. These peculiar troubles vary in intensity, as they are influenced by mental or bodily disturbance, but her condition at all times is pitiable. This is a case of *Graves's or Basedow's disease.* It sometimes, but rarely, attacks men. Exophthalmus, as a common symptom of tumors of the orbit, can hardly be confounded with exophthalmic goitre, when we remember that the former very seldom affects both eyes, and that the latter always does, though perhaps in different degrees. Then the peculiar combination of the three leading diagnostic symptoms of Basedow's disease—

the exophthalmus, the goitre, and the nervous palpitation of the heart—makes mistakes impossible.

Pulsating exophthalmus is rarely seen on both sides; is always of traumatic origin; and is distinguished by the striking pulsation and bruit over the region of the orbit. Its pathology is found to be rupture of the internal carotid into the cavernous sinus of the brain, and nothing but ligation of the carotid can relieve it. Many years ago I reported a case caused by the passage of a cart wheel over a man's head, where both carotids had to be tied before the symptoms could be relieved. How often do we diagnose *locomotor ataxia* by the extreme and persistent contraction of the pupils. Such pupils do not change in size under varying degrees of light, but contract instantly when the patient looks at and reads fine print, or accommodates for any small, near object. I recall a case in which the patient was first treated for diplopia, resulting from paralysis of the external rectus of one eye. From this he completely recovered in about a year. He consulted me again for slowly failing sight. This was at least two years after his first recovery. I then detected this peculiar smallness of the pupils, and beginning gray atrophy of the right optic nerve. The myosis persists to this day, notwithstanding total blindness in both eyes from optic atrophy.

A knowledge of the semi-decussation of the fibres of the optic nerves in the chiasm, and of their peculiar distribution in the retinæ, often enables us to fix the seat of a tumor at the base of the brain. Double optic neuritis generally means brain lesion, but does not locate it. *Hemiopia*, an extinction of vision in one-half the field, the dividing line being vertical—especially when it affects both eyes—may be a means of determining the seat of the lesion. For instance, darkness in the right half of the field in both eyes, means lesion of the left tractus opticus at the base of the brain, and *vice versa*. Blindness in both outer halves of the field (resulting from paralysis of the inner half of each retina) points to tumor of the pineal gland or the infundibulum, involving the posterior part of the optic chiasm. Extinction of both inner halves of the field, a rare occurrence, has been rationally explained, by Dr. Knapp, as indicating an atheromatous degeneration of the coats of the arteries in the circle of Willis. Other symptoms about the eyes help to fix the seat of cerebral troubles, but I cite these to show how much precision may be gained by observing the rational symptoms without the use of the ophthalmoscope. Indeed, in these cases, the instrument may be of no use whatever, as its findings are often negative.

Injuries and Diseases of the Orbit.

Injuries of the Orbit.—All serious life must be wrought out in the face of foes. Scars and mars of the face mean courage; wounds in the rear tell the sad tale of retreat and mortification. The eyes were planted in the face, to look ahead and insure progress. The motto of true manhood is onward and upward. It is not a mere question of animal existence, and the survival of the fittest. Fight we must, to live. But true nobility prompts to the divine art of healing, and of helping the weak. For these, and still higher reasons, wounds of the face and eyes are far more frequent and important than injuries of the occiput and podex. The jewel of the face and light of the soul, is the eye. Its precious safety is guaranteed by firm and prominent bony protections, and the delicacy with which the ball is pivoted in the socket. Its round form and easy rotation save it often from rupture and injuries that would otherwise destroy it. The application of blunt force is warded off by the bones. Penetrating weapons, unless very direct, pass the unharmed globe and enter the cavity. Contusions of the face are very frequent, but not often serious. A black eye is the result of such a contusion against the bony projections. Except when the violence is great, the concussion is not injurious either to the eye or to the brain. In direct blows on the eye, and in severe, indirect concussion, both may be damaged. Severe contusions, in addition to the bloody infiltration, are liable to be followed by inflammation and abscess. In predisposed subjects, or in times of epidemics, erysipelas with its alarming consequences may result. Orbital abscess, and loss of the eye, or even of life, is in that case to be apprehended. Periostitis and protracted trouble with the bones, are a rare sequel. Great depression, vomiting, and other evidences of cerebral disturbance, add gravity to the prognosis, and demand immediate attention. Contusions of the face and eyes are to be treated as they are elsewhere, never forgetting, however, the probability of erysipelas and abscesses supervening.

ORBITAL ABSCESSES should be detected and opened as quickly as possible. As a rule, the pointing-place of an abscess is the best place to open it. But pus-collections in the eyelids, or orbit, require special care. The incision should be parallel to, and as far as practicable from, the free margin of the lid. If the matter comes from the orbit, make the opening close to the edge, so that the cicatrix may not evert the lid. When the time and symptoms indicate a deep collection, an early exploratory puncture ought to be made, avoiding the eye and other important organs. If required, a free incision to the bone may be practised, and the exploration thence continued. If the reaction is erysipelatous, constitutional supporting treatment must be pushed from the start. Of course, warm fomentations, poultices, and other local treatment have their value. Abscesses in the orbit are rare, except after wounds and erysipelas. But I have seen them in parturition, in low forms of fever, and as an evidence of pyemia. The fistulous tract is usually very long in healing, and then is almost sure to end in an indrawn adhesion to the bone. Orbital abscess is very apt to result in total blindness, even when the integrity of the globe is preserved. The inflammation directly invades and disorganizes the optic nerve, and white atrophy of the papilla follows. The danger to the sight is particularly great in facial erysipelas. In penetrating wounds of the orbit, even with the presence of a foreign body, the sight sometimes escapes marvellously. In others the optic nerve may be directly severed or injured, and loss of vision, without any violent reaction, is present. I have seen this in several instances. Optic neuritis and atrophy, or the latter alone, have followed.

The *symptoms* of orbital cellulitis and suppuration, are pain, swelling, protrusion and fixation of the eye, and, generally, marked constitutional disturbance. These go on increasing in intensity, till fluctuation and pointing are detected. Even after free evacuation of the pus, the suffering from pressure within the unyielding orbit is apt to continue for several days. Vigilance and early incisions, in such collections, may save sight, deformity, and long, severe suffering. Recovery after these abscesses is always tedious, and the ball retreats to its natural position very gradually. If the bones are deeply cut or fractured at the same time, slower healing and suddenly fatal developments may be witnessed. Clean cuts of the face and eyelids heal promptly when properly adjusted. Extreme pains should be taken, by using deep, firm sutures, to so adjust wounds of the lids that the cut tarsus may not be notched or distorted. Healing by first intention is of the first importance. In view of the gravity of orbital cellulitis and abscess, treatment must be prompt and energetic. In most cases sight will be lost, and in the severest forms, the cornea sloughs and the globe atrophies. The starting point and nature of the reaction must be kept in view, in the rational treatment. Perfect quiet, warm poultices, often changed, anodynes, tonics, etc., inwardly, are the safest remedies. When the time comes for making incisions, they must be resorted to boldly, but not blindly. If erysipelas has extended to the orbit, the same local treatment and suitable internal remedies must be tried. If a penetrating wound is the starting point, the track must be dilated by means of grooved director and bistoury. Should the presence of a foreign body in the cavity be detected, it should be removed as quickly as possible. If caries of the bony orbit, or periosteal abscess, is at the bottom of the process, the chief attention is to be directed to that cause. The origin of this form of abscess is usually syphilitic, and the progress is very slow. The history, and a close observation of the course of the disease, will establish the diagnosis and direct the therapeutics. Evidences of dead and detached bone must be watched for with a view to its prompt removal. Deformity, in such a case, is inevitable. I introduce the following illustrative cases:—

I was consulted by an elderly lady, in very feeble health, for total blindness of both eyes. She had lost the sight some months before, during an attack of erysipelas of the face. There had been great protrusion of the eyes, and a discharge of matter through the lids, leaving retracted cicatrices. By inspection with the ophthalmoscope, I found the optic papilla in either eye very white, the vessels small, the margins ragged, and the surrounding retina hazy, showing the previous existence of neuro-retinitis. Facial erysipelas, extending to the cellulo-adipose tissue in the orbits, had destroyed the sight of both eyes.

As showing the danger to sight in spontaneous orbital cellulitis and abscess, I give the points of a case that occurred during the war:—

A man of 50 years sent for me in January, 1864, for severe swelling of the right eye. According to the patient's own account, he had been attacked with erysipelas of the face, in the course of which the inflammatory exophthalmus had made its appearance. From careful examination into the history of the attack, and an inspection of the face, I was convinced that the man had been seized with spontaneous inflammation and suppuration of the cellular tissue of the orbit, and that the swelling of the face and lids was but symptomatic of the orbital abscess. The globe was protruded directly forward and entirely immovable; the pupil was dilated and fixed, and all perception of light had vanished. The slightest pressure of the eye backwards or against the orbit produced excessive pain. Fluctuation was detected at the upper and inner, as well as at the lower and outer part of the orbit. Free incisions were made and pus escaped from both points. The patient recovered in a few weeks, but the eye was completely amaurotic. There was abundant exudation in the optic papilla and surrounding retina and choroid. Some weeks afterwards, atrophy of the papilla appeared.

A woman of 28 years was attacked two weeks after confinement by severe pain behind the right eye, with rapid swelling and loss of sight. When I saw her, a week after, I found the eye much protruded and immovable; enormous chemosis and swelling of the eyelids; almost complete insensibility of the cornea, with slight haziness; discoloration of the iris; pupil moderately large, but filled with lymph; no perception of light; severe pain on pressing the globe backwards. As the eye was already lost, I made no incisions. Three days after, under poulticing, pus began to discharge through the conjunctiva oculi, with occasional shreds of necrosed cellular tissue. About a week after this, when the swelling had very much abated and the eye had retreated considerably, the cornea became badly infiltrated, and soon sloughed away, leaving a shrunken globe.

A stout laborer was struck by the fist on the outer part of the orbit. Decided exophthalmus soon followed. The eye was limited in its movements, and very painful when pushed backwards. A few days after, fluctuation was felt through the upper and lower eyelids. I made free incisions, as usual, with discharge of matter. Excepting some symblepharon and slight impairment of sight, this patient got well.

Evidently here the suppuration was not deep behind the eye, and the vision was damaged, but not destroyed. In the case of spontaneous cellulitis, occurring in the puerperal period, the cornea was insensible from the beginning, and was finally destroyed by sloughing in consequence of its anæsthesic state. When the protrusion was greatest, the enormous chemosis covered and protected the cornea. As it subsided, the cornea was more exposed, and succumbed at a period when it would not, if the normal sensibility had been preserved.

In the history of surgery, many fatal cases of penetration to the brain, through the orbit, are recorded. I have referred to one or two, in my anatomical synopsis. Remarkable histories of large foreign bodies, lodged in the socket, have been given. Haynes Walton reports a case in which an iron hat-peg, three and three-tenth inches long, entered and remained in the orbit for many weeks. It was successfully extracted, the vision and movements of the eye remaining unimpaired. I myself saw Nélaton remove the ivory handle of an umbrella from the orbit of a man, after it had sojourned there three years. It was nearly two inches in length, and half an inch in thickness. I had seen the same patient before at Desmarres's Clinique. Military surgery contains accounts of many wonderful injuries of the orbit and eye, by gunshot projectiles and other weapons. A Union general, now living in Washington City, had both optic nerves severed by a ball that traversed from temple to temple, behind the eyes. I saw him some months after the casualty, and both optic nerves were white. Rising from the perusal of these histories, one feels that nothing possible, is *impossible!* Injuries and diseases of the antrum, frontal sinuses, and ethmoid cells, as far as they lead to troubles of the eye, can only be mentioned here. Bearing in mind their anatomical relations, the intelligent diagnosis of these diseases is not difficult. I have several times seen fistulous openings into the frontal sinuses mistaken for fistula lachrymalis. And what surgeon has not witnessed the professional alarm at emphysema, in wounds of the ethmoid and frontal sinus? Intelligence is always cool and collected. Ignorance is rash and emotional.

Tumors of the Orbit.—Almost every form of morbid growth found in the body, is represented in this cavity. In the various neoplasms that originate here, or encroach upon this space from without, there is one most characteristic symptom—exophthalmus. According to the seat and size of the tumor, will be the direction and degree of the protrusion of the eye. A growth in the funnel-space behind the eye, especially if quite at the apex, may not cause noticeable prominence for a long time. Impaired vision from pressure on the optic trunk, and disturbed circulation of blood in the retina, may be the first evidences of such an affection. At length the exophthalmus, usually in the direct axis of the orbit, attracts attention. But for a long time nothing can be felt by the finger, the eye filling so fully the space in front. Then, when the globe is almost out of the socket, the finger, pressed behind, detects the cause. I have notes of a number of such cases, of which the following three are samples:—

A stout lady, of ruddy complexion and perfect health, consulted me ten years ago, for blindness of one eye. There was white atrophy of the optic papilla and complete abolition of sight. She complained slightly of a feeling of pressure behind the eye. This condition continued, and at the end of about two years I noticed beginning exophthalmus. This increased slowly, and I determined to operate. The protrusion was direct, the rotation almost perfect, and by partially luxating the eye with my finger, I could feel a very firm growth pushing the eye forwards. The eye being hopelessly blind, I did not hesitate to enucleate it. This preliminary operation was extremely easy. I then had free access to a very hard mass, that completely filled the socket. It was thoroughly dissected out, and was found to embrace the atrophied optic nerve. Recovery was prompt. In about two years a reproduction was detected, growing from the apex of the orbit. Its progress was very slow and not at all painful. At length a second operation, to empty the orbit, was executed. Recovery, as before, was rapid. Now she has, after several years, a renewal of the morbid growth, filling the cavity, but causing no special inconvenience. She is, and has always been, in excellent general health. The only known cause of the development of this tumor was the sting of a bee on the eyelid.

The early history of a second case, I extract from the published Transactions of the International Medical Congress, held in Philadelphia in 1876:—

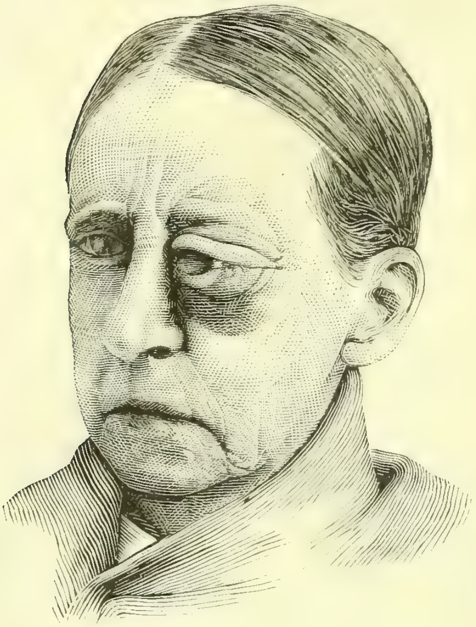
R. W., aged twenty-four, of stout figure, robust health, and sanguine temperament, was injured by the horn of a calf on Jan. 18, 1876. The point of the horn struck the lower lid, glancing inwards and backwards, and entering the orbit just above the tendo oculi, causing an ugly contused wound and a severe concussion. The wound bled profusely, but healed in the course of a week without surgical treatment. There was no bleeding from the nose; no ocular hemorrhage; nor was the patient rendered unconscious by the shock. Sight was not affected, and there was no diplopia, headache, giddiness, or other symptom of injury of the brain. There was no protrusion noticed. About five weeks after the accident, while stooping and driving a cross-cut saw, a sharp pain was felt above the right eye, running back over the ear to the temple. This sharp, peculiar pain came on at intervals, several times during the day, but was always provoked by stooping or straining, and soon passed off when the patient straightened himself up, and rested from sawing. There was no giddiness, throbbing, or bruit. Late in April, it was first noticed that the sight of the eye was misty at times, but without pain or other symptom of disease. For this failure in sight, a physician was consulted, who first detected an undue prominence of the eye. From that period, about May 1, for about three months, the exophthalmus increased slowly, but varied very perceptibly between morning and evening, being always greater in the morning. After that time it remained stationary. When I first saw this patient, in August, there was a striking exophthalmus of over one-fourth of an inch, with slight injection of the sclerotic conjunctiva, and some serous, chemotic swelling within the external commissure. Corresponding to this were seen some large, deep-seated, inosculating vessels on the sclerotic. The pupil was larger than the other, and somewhat sluggish. The movements of the globe were limited by its prominence, and by the stretching of the muscles, but there was no paralysis. There was a divergence when fixing with the other eye, and the motion upwards and inwards was less excursive, but there was no diplopia, which I attributed to the imperfect sight. Strongly marked features of swollen disk, and some neuritis; boundaries of the disk obscured, and veins very large and tortuous to their extreme branches; slight alteration of the macula lutea, blurring its distinctive features. Vision very defective in consequence of a large central scotoma, which patient expressed as well defined, but not complete. Tension of the globe, natural. No pulsation whatever of the globe, nor bruit on auscultation. When the eyeball was pressed directly backwards, it was arrested by a solid resistance.

Diagnosis: Tumor of some kind at apex of orbit, probably of aneurismal character. In the complete absence of the three most characteristic symptoms of aneurism—pulsation, bruit, and some degree of elasticity on pressure—I relied, in coming to this opinion, upon the evidently traumatic origin of the affection, upon its peculiar history, upon the absence of inflammatory symptoms, and upon the exclusion of the symptoms of either benignant or malignant tumor at the apex of the orbit. The symptoms followed so soon after the injury, and in the beginning were so characteristic, as to make this opinion more probable than any other. The sudden, sharp, severe pain running backwards over the temple, and caused by stooping and straining, coming on about four weeks after the blow, might be explained by the sudden rupture of the ophthalmic artery, directly as it entered the orbit through the optic foramen.

This patient was presented to the ophthalmological section of the congress for examination; but none of those present were willing to venture a positive diagnosis.

On April 15, 1877, the patient again called on me at my office. There was then great protrusion of the eyeball, with aggravation of all the other symptoms, and a tumor could now be felt behind the globe. Enucleation of the eyeball was resorted to, as the vision was then lost from optic atrophy. The tumor was readily removed. It was firm and fibrous in character, and the size of a small pullet's egg. It was situated between the optic nerve and the inner wall of the orbit, but was not firmly connected with either. The mistaken diagnosis in this case was perhaps excusable. It was certainly instructive. The recovery was permanent, and the patient wears an artificial eye. This indicates that the tumor was a benignant growth.

Fig. 857.



Fibro-sarcoma of orbit causing exophthalmus.

The third illustrative case has furnished the subject of Fig. 857:—

Mrs. B., 62 years old, applied for advice in November, 1881. She said that the disease had begun three years before, and assigned it to the sting of a wasp. Soon after, her friends noticed a slight prominence of the eye; she felt some discomfort when exposed to the wind and bright light, and, at times, aching pain. Nine months subsequently, the exophthalmus having increased and the pain being constant, she consulted a physician, who discovered a swelling at the outer, inferior margin of the orbit. For the next two years all the symptoms grew worse, till she was no longer able to close the lids without great effort. There was no history of injury, nor of any hereditary predisposition. Her health had never been robust, and yet she had, in her whole life, not suffered from any serious illness. At the date above given, the exophthalmus was enormous, the displacement being inwards and upwards; the cornea was clear and the pupil active, and she counted fingers at twelve feet; the ophthalmoscope revealed partial atrophy of the disk, with marks of neuritis; the margins of the papilla were ill-defined and irregular, and the veins tortuous. An elastic growth, filling the orbit, and projecting in a nodular form at the lower, outer part, could be distinctly felt. The patient was in constant dread that the eye would "come out of her head," and had to push it back often with her hand. When ready to enucleate, I pushed the lids back beyond the eyeball, where they closed in tightly, so that no speculum was needed. The removal of the eye was extremely easy, and I then passed my finger back and pulled out the tumor. It was moulded to the general form of the cavity, but was more prominent outwards. Dr. Robert Sattler's microscopic examination revealed a fibro-sarcoma. There has been no return, and the patient wears an artificial eye comfortably.

If the tumor is seated backwardly and inwardly, the eye will be pushed forwards and outwards. The displacement is always in the opposite direction to the seat of the growth. When far forwards, the eye is displaced laterally, and but little increased in prominence. Double vision is a common cause of worriment, when the dislodgment is indirect and considerable. If not directly invaded by the morbid growth, the rotatory muscles preserve their functions for a very long time. The limitation is first and chiefly noticed towards the side of the tumor, and is in proportion to its size. The lids stretch with the slow increase of the exophthalmus, and still cover the eye, even in the extremest cases. If the progress is rapid, the pain, impaired motion, double vision, and violent reaction from exposure, show themselves much earlier. In that event, ulceration of the cornea and loss of vision may be expected much sooner.

Of the many kinds of orbital growth, some are fatally malignant, others less so, and some harmless, except from the want of room. Some are extremely firm, others less so; some are cystic or mixed, others bony. In some instances the growth is very slow. These are apt to prove benignant. Others, of rapid progress, are more likely to be malignant. The different kinds of vascular tumor are generally traumatic, and sudden in their appearance. Exostoses are always of very slow growth, especially those of the ivory variety. When accessible to the touch, much may be learned of the tumor's consistence by that means. A case in point, of exostosis, is the following:[1]—

Mary E. T., 23 years old, of rugged constitution and in good health, consulted me March 13, 1878. It was difficult to procure a clear history of her case, on account of the patient's stupidity. For three years the family had noticed a divergence of the left eye when she fixed objects closely, or was embarrassed. About one year before, an unnatural prominence of the eye had been observed. Since that time exophthalmus and divergence had slowly increased, and the sight had disappeared. No traumatic or constitutional origin of the affection could be traced or even supposed. Her health had been uniformly good. The patient had a broad face, flat nose, and stolid expression. Her condition, when examined, was found to be as follows: The left eye was pressed upwards and outwards, and protruded to such a degree that the centre of the cornea was half an inch in advance of the other; the movements were limited downwards and inwards, but free in other directions. With that eye she had only vague perception of light, the sight of the other being perfect. The prominence was so excessive that slight pressure on the upper lid caused it to close in behind the ball. At the lower and inner part of the orbit a tumor was seen, dislodging the eye—bony hard to the touch, somewhat nodulated, but round, and extending deeply into the socket; the pupil did not respond to light, when the other eye was excluded, but remained large and fixed. With the ophthalmoscope I discovered marked neuro-retinitis from stasis; the entire retina was hazy, and the vessels were tortuous and obscured at many points with exudations; the disk was much engorged, and its margins were difficult to identify. It was evident that the eye was visually useless, and, the tumor being large, deeply seated, and firmly attached to the os planum of the ethmoid, I thought it safest and best to enucleate the eye and then remove the growth; this was done with the patient under ether. After enucleation, I found by the finger that the tumor was firmly united to the inner wall of the orbit, and extended nearly to the apex. Cutting through the capsule of Tenon and the periosteum, I denuded the mass as extensively as possible; then, with the bone-nippers, an effort was made to cut off a portion of it, but it was so hard that with my utmost strength I could only bring away very little. I then opened a strong pair of bone-forceps very widely, forced them over it so as to secure a firm hold, and by a few wriggling movements detached it *en masse* from its connections, and drew it out, thus completing the operation in a few minutes, and without any shock from chiselling or slipping of the forceps. But little bleeding occurred, and the patient soon rallied from the ether. Two days afterwards she returned to her home in the country; the following night, however, my assistant was called to her to arrest a severe hemorrhage from the nostril of that side. A section of the tumor measured 16 mm. in its longest diameter; in its transverse diameter it measured about 10 mm.; the rough bony pedicle measured 8 mm. in one direction, and 5 mm. in the other, showing that it was continuous with the os planum by a constricted neck. The entire growth came clean away, bringing no true bone with it. It was as hard as ivory throughout, admitting of a nice polish, and, when being sawed, emitted the peculiar smell of ivory. Its general form (supplying the portion that was chipped off by the nippers) was round, similar to a walnut, but nodulated and traversed by a deep fissure, which passed around it, between the pedicle and the convex portion that pressed against the eye. Its weight was 3 drachms, and with the portion that was chipped away would have been, perhaps, half a drachm more. No vessels were to be seen on its surface or in its structure. The patient returned about a year after the operation to procure an artificial eye, and there was no trace whatever of any reproduction of the tumor.

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[1] Transactions of the Am. Med. Association, vol. xxx.

These operations are always difficult and tedious, and often only partially successful. If possible, the eye should be preserved in all operations in the orbit. But sometimes enucleation is a necessity; and it always greatly facilitates the removal of an orbital tumor. If sight is gone, the sacrifice does not seem very great. Any mutilation, when necessary to save life, is justifiable. Very great care is needed to save the eye from injury, with its muscles and optic nerve. Sometimes one or more of the muscles must be cut, and the ball luxated by the finger, to secure access to the tumor. When the operation is completed, the divided muscles may be stitched, and deformity thus prevented.

Cysts originating in the ethmoid bone, and sometimes in the orbit, can only be treated surgically. They are filled with colored, ropy fluid, mixed with firm flakes. Free incision, syringing out the contents, and the use of irritating injections will generally succeed in effecting a cure.

The following case is typical of this class of tumors:—

A stout, healthy man from the country consulted me for a very high degree of exophthalmus of the right eye. A small scar just above the orbit was the result of a severe blow received when a boy. Besides this no other injury could be recalled. The protrusion was so great that the eyelids could only be closed by an effort. He dated the commencement of this symptom back only six months. The luxation was forwards, downwards, and inwards. A fluctuating tumor was felt between the ball and the upper and outer part of the orbit. I elevated the lid, and thrust a trocar through the cul de sac of the conjunctiva in the direction of the tumor. About an ounce and a half of ropy, slightly reddish fluid escaped. The ball sank back almost to its natural position at once. On his return in two weeks, a re-accumulation had taken place, but much less in quantity. A similar puncture was made with the same result as before. A few weeks later I saw him again. The exophthalmus was as marked as on the first visit. I then made a free incision, over an inch long, through the skin, parallel with the margin of the orbit, and opened the cyst extensively. After the escape of the contents, the sac was syringed with water, when three or four masses of coagula, each nearly as large as the little finger, were washed out. By examination with the finger the cyst was found to be very large, extending to the apex of the socket. As much as possible of the wall of the cyst was removed with scissors. For several weeks the cavity was daily washed out with water, and the incision kept open by a tent. Finally, the tent was left out, the wound closed, and the patient was well for about a year. The remaining exophthalmus was slight; the vision, at first much impaired, improved till he could read No. 8 of Jaeger's tests. He came back a year after with a decided return, which had appeared within two weeks. There was no pain, redness, or soreness on pressure. I incised the cyst freely as before, and about an ounce of pus, mixed with the same glairy, ropy fluid escaped. A probe detected denuded, but smooth, bone at the apex of the cavity. The wound was kept open as before, the cavity washed out daily with water, and injected with pure tincture of iodine. This was done for a week. The tent was continued for ten days afterwards, and at that time the bare bone was covered, and the cavity much reduced in size. Still, a little glairy fluid escaped each day with the pus. I then injected for three times, every second day, a 60-grain solution of nitrate of silver. In a week after that treatment I found the cavity very much smaller, and bleeding readily when touched with the probe. I then injected the iodine for three successive days. The tent was used for several weeks till the cavity was permanently obliterated, so that nothing was seen but an indrawn cicatrix.

Nothing but persevering and heroic treatment can destroy such cysts. I have repeatedly dealt with cysts of the ethmoid bone in a similar way. They encroach upon the orbit, interfere with the tear-sac, push the eye to one side, and demand treatment. Where the shell of bone over the cyst is thin, a peculiar feeling and crepitus are detected, when it is pressed with the finger. In one instance this was very striking.

Tumors of the optic nerve usually destroy vision, and the protrusion is in the direct line. In rare cases, the tumor and nerve have been removed, leaving the eye, but, as a rule, the useless eye is sacrificed, for the readier removal of the tumor.

Vascular tumors of the orbit, always attended by pulsating exophthalmus, present very different appearances, on post-mortem examination. In some, where this symptom was intensely marked, and a shrill bruit was audible over the eye, but little alteration was found after death, and this mostly in the cavity of the cranium. As a rule, these symptoms are found to be due to a traumatic rupture of the carotid artery in the cavernous sinus. I have seen but two cases of genuine aneurism of the ophthalmic artery. One was produced by a small shot that penetrated the orbit and wounded the artery. It was cured by compression. I published, many years ago, a case of very great protrusion of the eye, with pulsation, and a loud bruit, attended by optic neuritis. The papilla was greatly swollen, the vessels were very tortuous, and there were numerous hemorrhages in the retina. A cart-wheel had passed over the man's head a short time before the disease developed. The late Prof. H. E. Foote, at my request, ligated the carotid artery with temporary benefit. Six weeks after, the murmur and pulsation having returned, he tied the other artery, with the result of effecting a complete cure. In nearly all cases of tumor behind the eye, the exophthalmus and impaired sight are united with great swelling of the optic disk from venous stasis. In a man seen recently, with great prominence of the eye and but little sight, the swollen papilla was remarkable. It stood out into the vitreous with its round form perfectly defined, and the vessels passing up over it as if springing up on an artificial mound. By deep pressure at the upper and inner part, the edge of the retro-bulbar growth could be felt. Operative interference will soon be imperative. A malignant tumor of the orbit, in a little girl, became so large and produced such pressure, that in the midst of a fearful paroxysm of pain the whole superior maxillary suddenly separated from its fellow with an audible noise. The pain ceased instantly, and the teeth of that side projected half an inch beyond the line of the others. The detachment was from the median raphe. The child died a few weeks afterwards from invasion of the brain. The enormous size that these fatal growths attain, is almost beyond belief. In such extremities, death is a most welcome visitor.

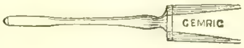
INJURIES OF THE EYEBALL.

That the eye is a *delicate organ* is best known to the surgeon acquainted with its sensitive structures and exquisite functions. In spite of the bony safety-box in which it is so nicely pivoted, the fatty cushion behind, and the watchful shutters in front, the eye is often surprised and seriously injured. Always open during the wakeful hours, it is constantly exposed to the vapors and fine dust of the atmosphere. Cinders and other particles driven by the wind, often strike the eye and fix themselves upon it, causing great suffering. It would be impossible to enumerate all the parts of seeds and grains, scales of insects, and other trifles, for which there is no room in the eyes!

Foreign Bodies in the Eye.—Foreign particles that remain any time in the eye, nearly always fix themselves in one of two positions. They adhere to the eyeball in front, generally to the cornea, or sweep under and fasten themselves on the inside of the upper lid. Rarely, they gravitate between the lower lid and the ball. Instinctive resistance to any sudden feeling of something in the eye, prompts to spasmodic closure of the lids and rude rubbing with fingers or knuckles. This often fixes and imbeds the cinder, while promptly seizing the lid and holding the eye open, would favor its escape with the gush of tears. The circumstances under which the trouble occurs, will often help to decide *what it might be*, but only a thorough examination can determine *what it is*. When consulted for a supposed foreign body in the eye, or when that is a possibility, though not suspected by the patient, a critical inspection of the cornea and the eyeball should be made. To do this, good light and good sight are indispensable. Separating and holding the lids gently apart, and directing the patient to turn the eye as desired, the surgeon makes a hasty search of the entire surface of the cornea. If the foreign body is very minute, of a dark color, and lodged near the centre of the cornea, it is better seen obliquely, as you thus get a background of iris rather than of black pupil. Should it be of light color, it will require very close attention to see it. *Oblique illumination*, using a large collecting lens of about three inches' focus, will materially aid the search. Common day light, and still better, a good lamp light, may be thus focussed upon the cornea, and promenaded over its surface. While the seat of the foreign body may be made clear by focal illumination, another similar lens may be used to magnify it and make its detection certain. By these aids, it cannot escape notice, however small. If nothing is found on the cornea or ball by a hasty but adequate inspection, the surgeon should evert the lids and scrutinize their conjunctival surfaces. The lower lid is easily everted by drawing it down towards the cheek, directing the patient to look up, but the foreign body is far more likely to be found under the upper lid. To evert it is not so easy, and requires professional tact. Seize the lashes near the middle of the lid with the thumb and index finger of the left hand, and direct the patient to look steadily and far down. Then drawing the lid slightly away from the eye, and downwards, you press a small probe, the end of a pencil, or even the tip of the finger, above the tarsus, sliding the lid down while the free edge is raised by the left hand, and the eversion is accomplished. Nothing but practice, with light and intelligent fingers, will make this important manœuvre easy. There is no one thing by which a patient who has been once handled by expert fingers, will detect awkwardness and inexperience as quickly as by the way the upper lid is everted. Finding the foreign body, probably on the tarsal surface, near the free edge of the lid, you can readily remove it, and the agony is over. Or failing still to find it, you next explore, as best you can, the upper, concealed folds of conjunctiva. Keeping the lid everted, and the eye turned far downwards, you place the probe on the skin far back, press it downwards, and then hoist it forwards, thus prying out the folds. Strings of matter, granulations, or warty excrescences, may be discovered surrounding a beard of wheat or barley, a grain of wheat, a piece of straw or splinter of wood, a husk of some seed, or other intruder. Thus it is found and removed. That done, little or no other treatment is required. The patient may have suffered for months, and been blindly tortured with the severest remedies. If only one eye has been affected with stubborn conjunctivitis, without chronic disease of the tear sac, this thorough search for a foreign body lodged in the upper folds should not be neglected. It will often lead to brilliant discoveries, and secure the lasting gratitude of the patient. I have removed scales of seeds, wings of insects, and other foreign bodies that had been fastened on the cornea, in plain view, for months, and the irritation aggravated by severe local astringents. I once found a dry stramonium seed in the upper cul-de-sac of the conjunctiva; it had been in the eye some thirty-six hours, and the pupil was widely dilated. Small particles of steel, stone, powder, and other hard substances, driven not by the wind but by mechanical forces, may not merely lodge on the eye or under the lids, but be more or less deeply imbedded. There is, then, generally, more reaction, pain, and traumatic inflammation, both before and after removal. If the foreign body be on, or imbedded in, the cornea, photophobia, spasm of the lids, and weeping, may seriously embarrass the examination and necessary treatment.

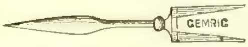
The *removal of foreign bodies from the cornea* is not always easy, especially when they are metallic, and have remained several days. Undergoing chemical changes, the oxidized substance incorporates itself with the corneal tissues, producing a dirty-rust ring. This will remain after the little mass of metal has been removed. By some persistence this ring can be detached. It is essentially foreign. A sharp spud, or a sort of gouge (Fig. 858), is better for removing particles from the cornea than a needle, and less dangerous in inexperienced hands. An operating chair or lounge may be used to seat the patient, or to lay him comfortably down. Standing behind or beside the patient, as may be most convenient, the lids are separated by the left hand, and the spud held in the right. In holding the eyelids securely open, with the thumb and index finger, care must be taken not to evert them. The patient is urged to hold the eye still in a given direction. The first touch of the cornea will make him wince from apprehension, but he will soon learn to control the eye. A good light and a favorable position for seeing the foreign body are indispensable. Then supporting the ball, with the lids well apart, the surgeon perseveres till he has completely removed the foreign body, with its stain, if such exist, doing as little damage to the cornea as possible. If the particle be more deeply imbedded, the spud may not succeed, and a broad needle (Fig. 859) will serve best. If the patient cannot control his eye, a speculum (Fig. 860), fixation forceps (Fig. 861), and even ether, may be used. In rare instances a scale of metal, piece of cap, or glass, may be driven so deep as to be ready to fall into the aqueous chamber. The least touch of the needle might push in the foreign body, when it would

Fig. 858.



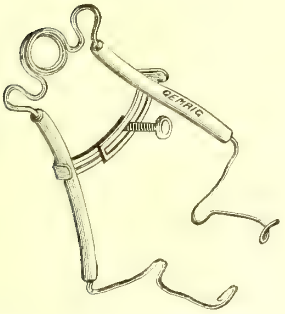
Spud for removing foreign bodies from the cornea.

Fig. 859.



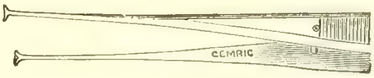
Broad needle for removing foreign bodies from the cornea.

Fig. 860.



Liebreich's spring-stop speculum for separating the eyelids.

Fig. 861.



Fixation forceps.

naturally fall to the bottom of the chamber and soon create violent reaction. The difficulties and dangers of removal would be then greatly increased. In every case where such an accident is imminent, thorough anæsthesia is necessary. The spring speculum and fixation forceps must be applied so as to secure the greatest accuracy in the use of instruments. A narrow, very sharp, spear knife, bent on the flat, must be passed through the cornea a little to one side of the offending body, and pushed carefully through the chamber till well behind it. Then by depressing the handle, the blade, with its flat surface, is brought firmly against the cornea, and the possible entrance of the foreign body into the chamber is blocked. While one hand thus carefully holds the foreign body, the other picks or prizes it out with a broad needle. The fixation forceps, at this stage at least, must be held by an assistant. No operation on the eye demands greater coolness and skill than the manœuvre described. Should the aqueous humor escape before the object is attained, the surgeon must desist and wait for its reaccumulation.

The length of time that a foreign body may remain buried in the cornea, undiscovered, is illustrated by a case in which a piece of wheat-beard was removed after two and a half years:—

A farmer, in September, 1866, while feeding a threshing machine, felt something strike the left eye. Severe inflammation followed, and he was kept in a dark room for two months. The eye then grew gradually more comfortable, so that he could work, but remained delicate, till in March, 1869, when severe suffering again set in. I saw him on April 29. There was vivid ciliary injection, and intense intolerance to light. A dark, grayish speck was seen in the centre of the cornea. By oblique illumination, a distinct projection from the corneal surface was detected. This was readily removed by a spud, and at the same instant the aqueous humor escaped. On examination, the substance removed proved to be a short piece of wheat-beard which had punctured the cornea, and which after that long period had worked to the free surface.

Accidental Wounds of the Eyeball.—These may be, (1) Incised, when inflicted by the blade of a knife, scissors, piece of glass, or any other sharp substance; (2) Punctured, as when caused by a pin, needle, thorn, or sharp, round instrument, such as the tine of a fork; (3) Mixed wounds, of a contused and lacerated character; and (4) Ruptures of the strong supporting tunic, generally of the sclera, by blunt force, such as the blow inflicted by a windlass, the horn of a cow, the fist, a ball, or a small stone.

Incised wounds, if clean, sharp, and not deep enough to open the eyeball, are not serious, and soon heal by simple rest with the eyes closed. Even when passing through the cornea or sclera, and of considerable length, if no prolapsus of the iris or ciliary body occurs, and if no deep-seated organ, such as the lens, is injured, they soon recover with the same treatment. If, however, the anterior chamber is opened, even by a small wound, the sudden loss of aqueous is very apt to wash the iris into the open cut, producing prolapsus. This is easily recognized by the little, round, dark prominence at the seat of the cut, looking something like the head of a house-fly. With that, the pupil will be more or less eccentric and altered in shape. It will be pear-shaped, with the small end at or towards the wound in the cornea or the sclero-corneal junction.

If the vitreous cavity is opened, prolapsus of more or less of that fluid will be likely to show itself. Even here, if the cutting body has not penetrated very deeply, and if no great loss of vitreous has taken place, with intra-ocular hemorrhage, the wound may heal with little injury to sight.

Punctured Wounds.—Wounds by a pin, needle, thorn, or sting of a bee, if deep, are extremely dangerous to sight, and are liable to be followed by disastrous inflammation, even of the uninjured eye.

I once treated a woman whose eye was put out by a pin. She was beating carpet, and the pin struck the eye with such force as to penetrate deeply through the cornea, iris, and lens. She suffered for many months, but recovered with a blind eye, the good eye never having seriously sympathized with it.

On December 31, 1881, a man was struck in the face by a bramble bush. He suffered repeated attacks of inflammation, the sight growing more and more cloudy, till July, 1882, when I saw him. There was a scar near the upper edge of the cornea, and a slight synechia anterior. I saw a piece of brier in the iris, and removed it by iridectomy with the portion of iris in which it rested. The other eye was hopelessly blind from previous disease, but the eye which was operated on recovered.

Thorns of black locust, honey locust, etc., often destroy the eye, especially when a piece breaks off and remains.

Wounds of a *contused* and *lacerated* character are nearly always disastrous to sight, and often lead to grave complications, involving the sight of the remaining eye, and even danger to life. Of course, the risks are greatly enhanced by the penetration and lodgment of the wounding body, or of something else that may be carried in with it. Intra-ocular hemorrhage and inflammatory disorganization from panophthalmitis, with its violent and protracted sufferings, are almost sure to follow, in any event. In all such fatal accidents to sight, if the eye would eventually heal and remain inoffensive, it would be a happy issue; but prolonged suffering and sympathetic danger to the fellow-eye are always to be apprehended.

Ruptures of the eyeball from blunt force take place in the sclera, a short distance back of and parallel to the base of the cornea. Simple rupture of the cornea is extremely rare. In ruptures of the sclera, the yielding conjunctiva generally escapes, while the lens is often driven through the rent and lodged under the mucous membrane. In that case, a large, round elevation, formed by the lens, whose color, perhaps, may partly be seen through the distended and semi-transparent conjunctiva, will indicate what has happened. I have repeatedly incised the conjunctiva and removed the lens after this accident, with preservation of even useful vision. Patients recover with very little suffering in these cases, and the rupture is not often the cause of sympathetic loss of the sound eye.

PENETRATING WOUNDS OF THE EYE.—A question of great importance, in all cases of eye-wound, is whether or not the offending body has entered the eyeball. To determine this, is by no means easy in very many cases. If the wound is large and deep, the immediate, partial or complete collapse of the globe, and the escape of a portion of its peculiar contents, reveal at once to the most ignorant, or even careless, the nature of the injury. But if the injuring body is small and propelled with great force, it may penetrate deeply into the eye with a scarcely perceptible wound, and almost without pain. The patient himself feels sure that it could not have gone into his eye, for he hardly felt it, and he often misleads his physician. It is well known to surgeons of experience that a small particle flying with great force, and lodging deeply in the eye, hurts much less than one moving slowly and lodging on the eye or under the lid. Besides, the pain is much greater for hours, and even days and weeks, afterwards, in the latter case than in the former. It frequently happens that a foreign body of minute size penetrates the eye, producing, sooner or later, cataract, or other serious trouble, and that the patient cannot remember when, where, or how the accident occurred, so little did it attract his attention at the fatal moment. This should warn us always to make a most minute and critical examination of the eye when the circumstances prove such an occurrence possible. For instance, a slight sting is felt in the eye of a bystander when a percussion-cap is exploded. He rubs the eye for a moment, wipes away a tear, and feels it no more. On close inspection, a particle of the cylinder is found to have passed through the cornea and lodged in the anterior chamber, the iris, or the lens—or even to have cleared all of these and gone deep into the vitreous—causing, perhaps, very little immediate impairment of vision. The first step in the diagnosis is to find the wound; the second, to determine whether or not it extends through all the coats of the eye; and the third, to ascertain if the injuring body has rebounded, has lodged in the tunics themselves, or has cleared them and entered the globe to remain. In seeking the wound, each part of the eye must be inspected in systematic order, beginning with the one most commonly injured, the cornea. In this examination we may be often guided, with some certainty, to the seat of injury, by the circumstances under which it occurred, and by the existence of a scratch or cut of one or other eyelid. But as the eye is nearly always open at such times, if the body is small it strikes the cornea directly, without grazing or passing through the lids. In these cases the diagnosis is often extremely difficult. The cornea, covered by its smooth, polished epithelium, acts as a reflector, forming images of objects in front of it. If the epithelium at any point be abraded or rough, a corresponding blur and defect will be seen in the sharp image of the window towards which it looks. The eye should be examined at an angle, and made to move slowly so that the little image may travel over all parts of its surface in succession. Another excellent means of detecting a very small scratch or wound in the cornea is by oblique illumination. Darken the room and light your gas or lamp, seat your patient facing it, and concentrate the light upon the cornea by a strong convex lens of two or three inches' focus. If an abrasion or wound, be it ever so minute, exist, you will thus see it. Of course, if the cut be large, with hernia of the iris, it is seen at once without these aids.

Discovered the seat of the wound, has it penetrated? If the iris is drawn into it by the escape of aqueous humor, forming a hernia, ever so small, *yes*. If the chamber has its relations altered—that is, if the iris is near or in contact with the cornea, whether prolapsed or not—*yes*. If there is blood in the chamber, much or little, without the possibility of a severe concussion of the eye, with or without unnatural softness of the ball to the touch, *yes*. If a small hole is seen in the iris, corresponding in size to the corneal wound, and in the probable direction of the penetrating body, with or without blood in the chamber, or alteration of the depth of the chamber, *yes*. If the foreign body can be certainly seen in the iris, lens, or chamber, *yes*. If, with the wound of the cornea, with or without changes in the chamber or the tension of the globe, the lens is becoming certainly milky, showing beginning cataract, with perhaps a visible wound in its capsule, *yes*. All of these symptoms failing, in a case of manifest wound of the cornea, you dilate the pupil and use the ophthalmoscope. If the fundus of the eye is darkened by blood, the circumstances precluding rupture of intra-ocular vessels, there is almost certainly penetration. If the foreign body can be positively seen within the organ—in the chamber, iris, lens, vitreous, or retina—the diagnosis is sure. Of course, impairment of sight and the appearance of a cloud in the field of vision, caused by extravasated blood or the foreign body, or both, come in as corroborative evidence of penetration. The sight may be destroyed at once or very soon; or it may be little affected, according to the size, direction, and final resting place of the offending body. The value of softness of the globe, as an evidence of penetration, is very great, when it certainly is present. But the tension is often not altered. If the foreign body is small, it may pass deeply into the eye without any escape of humor, either aqueous or vitreous, and hence may leave the tension normal.

When the patient is not seen for some minutes, hours, or even days after the injury, the wound may be firmly closed, and the lost humors reproduced, so that undue softness is no longer present. The reproduction of lost humors is very rapid, as is known to all operators on the eye. In fact, if the patient is not seen for several days, the eye may be too hard, from internal inflammation and secretion; this increased tension then becoming the indirect evidence of penetration.

The ophthalmoscopic evidence of penetration, when positive, that is, when the body itself is seen, or suffused blood, or a cloudy sleeve of opacity along its track in the vitreous, is quite sufficient. Still, the result of such an examination may be altogether negative, and yet the offender be in the eye. Should it rest far forward in the vitreous—behind the iris or ciliary circle—it is detected with great difficulty, if at all. In that case, there being none of the symptoms already emphasized, we should make a reserved diagnosis and wait for further developments; should the extraneous body be in the eye, it is almost certain to give rise to trouble sooner or later. Moreover, the supposed visible intruder may prove to be a globule of blood, or air, or both; but that does not invalidate its importance as an evidence of penetration. On the question of the actual presence of the foreign body in the eye, it may leave doubt which can only be cleared up by time. So the cloud seen by the patient, after an injury, may or may not be caused by the presence of a foreign body in the globe, but is strong presumptive proof of penetration.

But the eye may be struck behind the cornea, in the sclerotic region. And as this part of the globe is covered by conjunctiva and capsule of Tenon—both being thin, elastic, and movable over its surface—the wound may easily escape notice when small. Its torn edges, and especially the ecchymosis, always, perhaps, present for a short time after the injury, will attract attention to the injured spot. The thing, then, has struck there, but has it entered? If the spot is over the sclero-corneal junction, or very little back of it, we may still look in the anterior chamber for signs of the passage of the wounding body. The iris may be wounded near its ciliary margin, or a small knuckle of its periphery may protrude through the wound. Blood in the aqueous chamber has here also the same positive significance as in wounds through the cornea. Should neither prolapsus iridis, hemorrhage, nor any appreciable rent in the iris be discovered, it is still wise to make a scrutinizing search with the ophthalmoscope, in this, as in all cases of suspicious injuries of the eyeball. Physicians in general pass too lightly over such accidents, assuring the patient at once, perhaps, that nothing is in the eye.

I would insist upon the importance of small wounds of the iris, sometimes forming a sharp hole in this curtain, admitting light, and giving a red reflex from the bottom of the eye with the ophthalmoscope. They prove not only penetration, but the almost certain presence of the foreign body in the back of the eye. A very small hole or cut in the iris, can only be made by the passage of a very small body, and one which must clear the cornea before striking the iris. Rebounding in that case is impossible. Such an injury could only be caused by a small body, or by a pin or needle, a splinter, or some long, slender projectile. In the latter case, the missile might rebound. If, however, it has also cleared the iris, and is hence invisible, it may be found in the suspensory ligament or margin of the lens, or in the vitreous behind it. The body being small and the edge of the lens barely grazed, there is not likely to be traumatic cataract—an infallible evidence of penetration when it is detected. The ophthalmoscope may or may not detect the foreign substance in the fundus. The same observations which were made above about ophthalmoscopic evidences of penetration, and their significance, apply here.

If the wound in the conjunctiva and sclerotic is large, and made either by a large body entering directly, or glancing, there will probably be loss of vitreous, recognized by its characteristic ropiness, and flabbiness, or collapse, of the globe. In this event, the foreign body may be lodged in the globe or not. In such destructive injuries there is almost certainly free hemorrhage within the eye, preventing any immediate inspection of the fundus. But a wound of the sclerotic conjunctiva does not necessarily indicate penetration. The injuring body may have glanced backwards, between the conjunctiva and sclerotic, piercing the latter perhaps in the region of the equator, or sparing the globe and plunging deep into the socket. Sometimes a shot, or scale of metal, when driven with great force, passes entirely through the globe and lodges in the apex of the orbit. In rare cases a rough scale may be found grasped by the sclerotic, after having traversed the vitreous.

Some years ago a machinist called on me with an injured eye. There was a large ragged wound in the sclerotic, the ball being flabby and filled with blood. I was sure that a rough scale of metal had entered deeply and had remained in the ball. Immediate enucleation was urged, but the patient would not consent. The eye was hopelessly lost, and great suffering was certain to ensue, with much danger to the other eye, and even to life. But I could not move him from his conviction that there was no foreign body in the eye, and that the sight could be restored. Of course I refused to prescribe, or to take any responsibility in the case, and the patient left me. Two weeks afterwards he returned, with fearful swelling of the eye and face, excruciating pain, and commencing rigidity of the muscles of the jaw. In this extreme condition, hopeless as it was, he begged for enucleation. The operation was very difficult, and when at last the optic nerve was embraced by the scissors, they would not close. After much trouble, however, I succeeded in removing the eye. A large metallic scale was found embraced by the wounded sclerotic, one end projecting backwards by the side of the optic nerve. The tetanus continued, as I expected, and after the most fearful sufferings I ever witnessed, the poor victim died, two weeks after the operation.

Another somewhat similar case was operated on by my associate, Dr. S. C. Ayres, on the 10th of April, 1876. Immediately after enucleation, the ball was opened and examined. To our surprise, no foreign body was found, but a cicatrix, three lines in length, was detected in the sclerotic just below the optic nerve, through which it had passed out of the eye into the orbit. The socket was at once examined by the operator's finger, and the end of the foreign body distinctly felt, wedged back into the apex. With a good deal of trouble, it was seized and removed by the forceps. It was five-eighths of an inch in length, and three-eighths in breadth, and somewhat like a piece of knife-blade.

I have, several times, enucleated eyes where the sight had been destroyed by birdshot, and where none were found in the globe, but distinct cicatrices of entrance and exit. Such shot or bullets may sojourn in the socket perfectly harmless. In one instance, however, I saw an aneurism of the ophthalmic artery developed some months after such an injury. Occasionally a penetrating body, or a shot, spares the eyeball, but plunges behind it and wounds the optic nerve, causing instant loss of sight.

Sudden loss of sight following a penetrating wound of the orbit—the eyeball itself having escaped injury—may thus be accounted for.

I once saw a young man who had fallen from a load of hay on the sharp, slender tine of a steel fork. He jerked it out, with some difficulty, but never saw light afterwards. When I examined him many years afterwards, I found the cicatrix in the upper lid, but no trace of injury in the globe. On ophthalmoscopic examination, I found nothing but extreme white atrophy of the optic nerve. It is almost certain that the nerve had been wounded, perhaps severed, by the fork.

A still more interesting case occurred in my practice, some years ago. An old gentleman received an accidental discharge of birdshot in his face, with immediate total extinction of sight in both eyes. Two days afterwards I saw him, and found his condition, briefly, as follows: The right eye was collapsed and riddled by shot, and there were numerous marks of others that had entered the face and lids of the same side. The left side of the face showed only one mark of a shot in the lower lid, opposite the edge of the bony orbit. The pupil was largely dilated and fixed, with bare perception of light. Otherwise the eye was intact, and the ophthalmoscope revealed absolutely nothing wrong. The disk appeared natural in all respects, and moderate pressure with the finger on the globe produced the usual visible pulsations of the arteries on its surface, showing that the main retinal artery, as it enters the trunk of the nerve a little back of the globe, and follows in its axis to the interior of the eye, had not been injured. I diagnosed injury of the optic nerve some distance behind the globe, beyond the point at which it receives the artery. The patient suffered great pain in the right eye, for which I was induced at last to enucleate it. One shot was found in the bottom of the vitreous, but the others had passed entirely through, into the orbit. He was altogether free from pain afterwards. The vision of the left eye gradually returned, so that he could see to walk about, recognize persons, and read large print. The optic nerve showed moderate white atrophy.

An enumeration of all the kinds of foreign body that have been known to penetrate the eye would be an impossible task. The most common are pieces of metal, percussion-caps, fragments of stone or wood, and shot. Sometimes we are surprised to find the foreign body very different from what we had expected from the history of the accident and the nature of the wound or cicatrix.

For instance, a little boy, five years old, was amusing himself by exploding caps, laying them on the pavement and striking them with a stone. A fragment struck the inner segment of the cornea, and made a wound of about one line in length. For some days he did not suffer much pain, and his physician thought the injury was not serious. At length, the inflammation and pain increasing, he was brought to me. The iris was discolored, and pressed forward almost in contact with the cornea; the lens was opaque; the foreign body had evidently passed through the cornea, the iris, and into or through the lens. It was not possible to detect it. I enucleated the eye, expecting, of course, to find a piece of cap in it. After severing the recti muscles I passed my finger behind the globe to luxate it. The pressure caused the corneal wound to open, and the soft opaque lens escaped from the eye. I caught it, fortunately, and dropped it into the basin. On finishing the operation, and opening the eye very carefully, I found no piece of cap; the lens in the basin was then examined, and a small piece, not of the cap, but of *stone*, was found in it.

Another time, an eye had been extinguished by the sudden discharge of a gun-cartridge. The evidences of penetration, and of the presence of a foreign body deep in the eye, were clear. I discovered in the enucleated eye a piece of *mother-of-pearl!* On careful inquiry, the patient confessed that he had been foolish enough to strike the cartridge with his pearl-handled knife; the cartridge exploded, and all that he ever saw of the knife was the piece of pearl found in the vitreous.

Another man, while handling some pieces of wood, felt something, he did not know what, strike his left eye. It produced a triangular, incised wound of the cornea, injured the lens, and caused cataract. Sight was lost at once, and for seven weeks he suffered constant pain. At that time the cornea was flattened, opaque in the centre, and apparently drawn down by the cicatrization; the ball was tender to the touch, over the ciliary region; the sclerotic and ciliary zone were intensely injected. On removal, the vitreous was found liquid; the retina in position, but in thickened, opaque folds. Corresponding to the corneal wound was a cicatricial, tense ridge, or band, running across the ciliary processes, and having a firm, fibrous feeling and resistance. Within this cicatrix was included an *eyelash*, lying in the direction of the cicatrix, with the bulbous end farthest from the cornea. No other foreign substance was found; the wounding body had carried the cilia in, and had left it, after rebounding.

The presence of a foreign substance remaining in the ball, after penetration, increases the gravity of the case more or less, according to its nature, size, greater or less roughness, and especially its position. A small, smooth body may become encysted in the vitreous, and remain harmless. Indeed, this may occur, but rarely, when it is in the iris, retina, or choroid. In such instances its presence is nearly always resented, and it keeps up endless trouble and never-ceasing danger to the other eye. When fixed in or near the ciliary region—the most usual place—there is certainty of trouble sooner or later, and great danger of sympathetic ophthalmia. It is in the lens, perhaps, that extraneous bodies are longest tolerated, after producing cataract. But eventually they may escape from the lens and produce violent and destructive reaction:—

A man while opening a keg of paint, in April, 1875, with a hammer and chisel, felt something strike his brow, bringing a drop of blood; at the same moment a stinging sensation was noticed in the eye. There was no pain following the accident, and he insisted that the sight remained perfectly good until three weeks before I saw him, which was over a year. At that time, May 22, 1876, he could only count fingers at 3½ feet. There was cataract, but without complete opacity. Deep in the lens was seen a shiny, small piece of metal. In the anterior capsule was a visible wound, with a tuft of lens-substance protruding through it into the aqueous, and undergoing absorption. In the cornea, a small scar was found where the metal had entered. The patient called to consult me about the failing sight. I advised him to wait a few weeks, as he was suffering no pain. There were no urgent symptoms. I believed that the absorption through the rent in the capsule would go on, and that eventually the foreign body would come forward and be more easily and certainly removed with the lens. Before long he returned, having suffered intense pain for the previous ten days. The foreign body had come forward, out of the lens, and had fallen into the anterior chamber. It was very small, but distinctly visible, lying in the lower rim of the anterior chamber. The patient having been etherized, I made a careful incision at the sclero-corneal junction close in front of the offending substance. The corresponding part of the iris was then drawn out and snipped off, bringing with it the piece of metal. It was not larger than half a pin's head.

I had another case under observation, where a piece of metal, of much larger size and of crescentic shape, had penetrated the lens some years before, and still remained there—the whole opaque lens-substance having become liquid. The foreign body moved freely around in the closed capsule, according to the position of the head, always gravitating to the most dependent part. No doubt the fluid lens-substance was gradually absorbed, and the capsule closed in more and more on the foreign body, limiting its excursions. It probably cut through the capsule and ultimately fell into the aqueous chamber. The patient suffered no inconvenience from it, except the blindness.

Some years since, a young man was brought to me suffering severely from an eye that had been injured, ten days previously, by the explosion of a mineral-water bottle, which he had been holding in his hand. He felt a sharp sting in the eye, followed by bleeding. For the next twenty-four hours he did not suffer much, and could see large objects. Severe pain then set in; sight was extinguished, and he came to me in that condition. There was a cicatrix in the lower lid, about a quarter of an inch long, just below the margin, and occupying its entire thickness. In the lower part of the sclerotic, through the ciliary region, exactly corresponding to the scar in the lid, was a penetrating wound a quarter of an inch long, with two little radiating branches. The pupil was largely dilated, and the fundus of the eye showing a marked yellowish reflex, indicating extensive suppurative choroiditis. I felt very confident that a large piece of glass was in the eye, but the turbidness of the vitreous prevented my seeing it. Enucleation was performed. There was extensive suppuration in the vitreous, extending from the sclerotic wound across the ciliary body, with neuro-retinitis in a most intense form. The optic disc was greatly swollen, completely obscuring the vessels, and presenting the characteristic appearances of neuritis; but no foreign body was found in the eye. A long, slender, wedge-shaped piece of the bottle had passed through the lid, deep into the eyeball, and had then rebounded.

The pages of our experience, written and traditional, are full of marvellous accounts of foreign bodies tolerated in the eyes for years. One instance, from my own case book, must suffice:—

An Irish stone-cutter had his left eye put out by a piece of stone. Shortly after, the right eye was injured by a knife, causing traumatic cataract. This Sir William Wilde extracted, giving the man "good sight" for over twelve years. Then iritis attacked it, producing a false membrane in the pupil so that he could not work, and in that condition he came to consult me, fourteen years after the loss of the left eye. This eye was atrophied, and on examination, a piece of stone was seen projecting from it, directly between the lids. The visible part was about one-quarter of an inch long, the end in the shrunken eye being larger than that which was seen. So the sclera was incised and the piece removed. It was half an inch long, and a quarter of an inch wide at its widest end. When the right eye had been operated on for traumatic cataract, and restored to useful sight, the left, containing the foreign body, was not atrophied, but painful. The pain persisted for twelve years, when sympathetic iritis set in, impairing, but not destroying, the sight of the right eye. Soon after this the left ball shrank, passing into the condition in which it was when I saw him. Fortunately, the sight of the right eye was such that by fitting it with a cataract glass he could see to shovel dirt, and was satisfied.

SYMPATHETIC OPHTHALMIA.—If while one eye is suffering from an injury or an inflammation, the other is attacked by disease, not fairly attributable to any other cause, we call it sympathetic. Sympathetic ophthalmia embraces a variety of lesions in different parts of the eye, all recognizing a common cause. Although traumatic inflammation of one eye is the most frequent cause of sympathetic destruction of the fellow eye, still this may arise from other troubles. The presence of a foreign body in the injured organ increases the danger to the other. The most dangerous region is the ciliary, embracing a narrow zone around the cornea. It is very liberally supplied with nerves and bloodvessels.

Dr. Alt says that seventy-six per cent. of sympathetic diseases are referable to trouble in the ciliary body of the offending eye. The iris is usually involved at the same time, a complication called irido-cyclitis. Not unfrequently, and in the most dangerous cases, the whole uveal tract and the retina become implicated. But very rare instances arise of fatal sympathetic loss of one eye, where the iris, ciliary, and choroid in the other, have not been affected. A phthisical globe, perfectly painless and free from all outward manifestations of irritation, has been supposed to give rise to sympathetic disease. In the majority of cases, however, it seems to be bony degeneration of the choroid in such stumps that finally provokes pain and irritation, and sympathetic trouble. Cyclitis, or irido-cyclitis, whether traumatic or spontaneous, seems to be the immediate provocation of sympathetic suffering. Injuries in this dangerous region, especially when complicated with prolapsus of the iris or of the ciliary body, always involve very great danger to the fellow eye. If, in addition to the wound and its complications, a foreign body is lodged in the eye, the danger is heightened. The resulting inflammation is then much harder to subdue, and returns on the slightest provocation. Even when the foreign body becomes encysted in the ciliary region, and remains harmless for many years, it is liable to be dislodged and to give rise to serious trouble in both the injured and the well eye. Accidental and surgical injuries of all kinds in this region are necessarily serious.

In the past fifteen years, numerous cases of sympathetic destruction of one eye, following a Graefe's extraction in the other, have been reported. Few operators of large experience, have been saved from this sad disaster. Worse than this has happened to me and to others:—

A few years since, I operated successfully on an eye for cataract. All went so well that, in a week, yielding reluctantly to the urgent wishes of the patient, I extracted the other lens. Fatal reaction followed; the first eye became involved in sympathetic inflammation; and the patient was left hopelessly blind.

Even iridectomy has been the cause of loss of the fellow eye, but the danger involved is excessively small.

I recall the case of a young lady who consulted me, many years ago, for a large prolapsus of the iris at the upper margin of the cornea. It had existed for years, and was the result of a perforating ulcer. Although quite large, it was covered generally by the upper lid, and the eye was useful. I clipped it off with scissors, and in a few days ugly iritis ensued, and persisted stubbornly. At length it abated, and the patient returned home to the country. Some months after, she came back with complete disorganization and blindness of both eyes. In such a case, with a prolapsus having a large neck, lined with membrane of Descemet, connecting with the aqueous chamber, and of long standing, I should be very careful.

After one of my earliest extractions by Graefe's linear method, there remained a moderate prolapsus of the iris at one angle of the incision. The lady, now over 80, has a prolapsus as large as half a grain of wheat, covered by the upper lid, causing her no inconvenience, and with a rare vision of 1.

Of course, hernia of the iris, making traction upon the ciliary and other structures, and keeping up persistent and dangerous cyclitis, may be the result of simple ulceration and perforation of the cornea, as well as of injury.

In the most serious forms of irido-cyclitis, there is one symptom of peculiar significance. I mean habitual tenderness to pressure at some particular point in the ciliary region. It is nearly always above, and can be detected by pressure with the finger through the lid, or with a probe. The moment the sensitive point is pressed upon, the patient involuntarily shrinks and complains of pain. This important and never-to-be-forgotten symptom is not always present, but when it is detected, great and imminent danger is to be feared. It oftener exists when the painful eye is blind and shrunken than when it is plump. If the local tenderness of the stump is due to bony deposits, the sensitive and very hard points are far back. But they import serious danger here as well as in the ciliary region. With this symptom of local tenderness to pressure, with more or less constant irritation of a blind eye, the surgeon should not hesitate to urge immediate enucleation.

"The following list," says Dr. Ludwig Mauthner, "comprises the sympathetic diseases of the eye: neuralgia of the ciliary nerves; irritation of the retina and of the optic nerve; functional disturbance of the retina; inflammation, severally, of the conjunctiva, cornea, and choroid; inflammation of the uveal tract, with or without participation on the part of the ciliary body, so that there may be both a sympathetic iritis and a sympathetic choroiditis, without coexisting cyclitis; inflammation of the retina, alone or in conjunction with inflammation of the choroid; inflammation of the optic nerve; glaucoma; disease of the vitreous and of the lens." It is questionable whether some of the cases reported, and from which this list has been made up, were genuine cases of sympathetic disease, or only accidental occurrences.

My limits will not admit of discussion as to the channels by which disease may extend to the fellow eye, and the mode of its propagation. The general belief is that the morbid process extends directly from the injured to the other eye, and is not the result of reflex, excito-motor influence. In addition to the route of the ciliary nerves, the frequent presence of optic neuritis or neuro-retinitis in enucleated eyes, would indicate that the optic nerve and its sheath were perhaps frequent channels of morbid communication. The sensory branches of the trigeminus, so freely distributed to the ciliary muscle, iris, and cornea, through the long and short ciliary nerves, would perhaps account for the great frequency of sympathetic affection after injuries and diseases of those structures, especially of the ciliary region and the iris.

The fellow feeling existing between the eyes is vividly manifested, in all acute and painful affections of one eye, by the tenderness to light, spasm of the lids, weeping, and ready fatigue of the other. If this is not identical with, it is certainly very similar to, the "*sympathetic irritation*" which is so often the precursor of sympathetic ophthalmia. It is true that the early and intense suffering of one eye with the other, in the beginning of acute affections, whether of traumatic or idiopathic origin, generally subsides in a few days, while the sympathetic irritation that forebodes danger to the sound eye generally does not come on for some weeks or months; still, the persistence of the suffering of the early stage for weeks or longer, without abatement, certainly indicates quite as much danger of sympathetic loss of the sound eye. While, in either case, the irritation and functional weakness may continue for years without issuing in destructive inflammation, it is wise to to act on the assumption that such danger is ever imminent. While it is undoubtedly true that neuro-retinitis may extend from the injured to the well eye, following the optic nerve through the chiasm—and that irido-cyclitis, through the ciliary nerves, often gives rise to inflammation of the same parts in the sound eye—it is certain that optic-neuritis in one eye can only excite the same disease in the other, and not cyclitis; and *vice versa*. Where the two diseases are found together in the offending eye, they may likewise be associated in the other, sympathetically. When the known conditions of danger exist, there are certain premonitory symptoms, which sometimes result in sympathetic ophthalmia in a few days, and at other times not for weeks or even months.

This warning irritation is of immense practical importance. If it is recognized, and the offending eye promptly removed, before actual sympathetic inflammation of any kind has been set up in the fellow eye, the patient is saved from blindness. The exceptions to this rule are extremely rare. In my own large experience I do not recall a single one. What then are these alarming symptoms? One of the most common, is a certain vague smokiness before the eye, with difficulty in focusing small objects. If the patient strives to read fine print, it is difficult, and soon becomes painful. The pupil is usually sluggish, rather dilated, and the patient often speaks of a wavering mist before him, like the glimmerings of a heated atmosphere. These disturbances are often periodical, and perhaps worse when the diseased eye is suffering paroxysms of pain. Tested in the usual, accurate way, the vision is below the normal. Sometimes flashes of light, changing colors, and photopsia of various kinds and degrees, torment the patient. Rarely there are extreme intolerance to light and harassing blepharospasm. These symptoms of retinal irritation are occasionally attended by concentric narrowing of the field of vision, as well as by marked dimness of direct vision. With these symptoms, there may be the faintest blush of redness in the ciliary region, but often there is none at all. Much of the indisposition to fix on and focus small objects, is due to the pain produced in the injured eye by efforts of accommodation. Should these warnings come on while the injured or diseased eye is subject to paroxysms of more or less severe pain, or if, in the absence of spontaneous pain, there should be found a tender spot over the ciliary region, danger is impending. This tender point in the useless eye is characteristic of cyclitis, and sometimes a corresponding one is found in the threatened organ. Nearly always above, it may be detected by pressure with the finger or a probe through the upper lid. The moment the sensitive place is reached, the patient winces. In cases of quiescent atrophy of the globe, dating back many years, ossification of the choroid, or calcareous degeneration of the lens, may at length give rise to pain, tenderness, and sympathetic danger. The shrunken stump then becomes hard and painful to the touch, especially posteriorly.

I recently removed such an eye from a gentleman, fifty years old. It had been put out by a pen-knife in boyhood, and never gave the least discomfort till within the past two years. It then grew painful and tender to the touch, and gave rise not only to sympathetic irritation in the sound eye, but at times to excruciating attacks of facial neuralgia, and to falling fits of unconsciousness. All these symptoms disappeared when the eye was enucleated.

An eye, whether plump or shrunken, that contains a foreign body, is always liable to become troublesome and dangerous to its fellow.

How long after the injury does it require for sympathetic ophthalmia to be set up? I have known it to be developed in three weeks. Mauthner never saw it occur sooner than four weeks. The interval may vary from three weeks, which seems to be the shortest time, to months, and even to forty or fifty years, as in the case above cited. The reported cases of neuro-retinitis and other forms of sympathetic ophthalmia, coming on in a few days after enucleation, were not caused, as alleged, by the enucleation. The diseased process was on its way around, before the operation, and would probably have broken out at the same time, had nothing been done. It is hard for me to believe that the contusion of the optic and ciliary nerves by the scissors, in enucleation, could produce sympathetic disease. At least, I have had the good fortune to be spared seeing such cases. That traction on, or constriction of, the optic nerve, after enucleation, may excite to sympathetic irritation, was, however, demonstrated by a case of my own:—

I had enucleated the painful eye some months before. The patient returned, complaining of harassing photopsia, glimmering, and tenderness to light, so that he could not apply the sight of the eye. All these symptoms were at once relieved by a little leather pad, pressed firmly back into the hollow socket by a bandage, which he had worn for weeks. By an operation, in which a piece of the nerve stump was detached and removed, all trouble ceased. Such cases have been reported by others.

That similar disturbances might result from cicatricial compression of the ciliary trunks, I can believe. Under all the circumstances, where sympathetic inflammation of the good eye has been observed, and with the premonitions of sympathetic irritation, eternal vigilance is the price of sight.

By far the most frequent form of sympathetic inflammation, is irido-cyclitis, extending in the worst cases to the choroid. Beginning usually with the symptoms of an ordinary acute or subacute iritis, but resisting all treatment, and leading to firm agglutination of the entire iris to the capsule of the lens, it results at last in hopeless disorganization. Cyclitis, with tenderness to pressure, softening of the globe, and slow but fatal extinction of vision, follow in the train. Sometimes encouraging remissions will be seen, but soon the turn comes and all is lost. In the simple form of serous iritis, sometimes seen, enucleation is not necessary, as the disease may be controlled without. In the plastic and malignant variety, most often witnessed, enucleation does no good, and may often do harm.

But in other forms of sympathetic manifestation, especially those showing neuro-retinitis, it would seem as though enucleation exercised a favorable influence. Watchful anticipation and prompt surgical interference, before or as soon as the ominous sympathetic irritation has set in, is the only sure and safe treatment. Whenever a hopelessly blind eye is, and perhaps has long been, comfortable, with no local tenderness to pressure, and when the other eye is perfect, with no evidences of sympathetic irritation, it is useless to mutilate the patient out of foolish fear of danger. On the other hand, even a partially seeing eye, after an injury, should be sacrificed without hesitation if alarming symptoms of danger to the other eye have set in.

In destructive injuries of the eye, with evidences of a concealed foreign body, or even without, it is often a wise precaution, to enucleate as soon as possible after the fatal injury, before violent reaction has set in. In that way the patient is saved from protracted and severe suffering, as well as from danger to the fellow eye. But even after severe panophthalmitis has set in, in case tenderness to light, cloudiness of vision, glimmering, and other alarming symptoms are developed, I should resort to removal of the offending eye. I have done it several times, with none of the fatal consequences described and feared by Von Graefe and so many others. While I would warn against the extreme view that every blind eye, whether from disease or injury, ought to be enucleated, and that any trouble that comes to the fellow eye is presumably sympathetic, I would still emphasize the fact, that *any blind eye*, at any time *may* become a source of risk. This is particularly true if an artificial eye is worn over an old, atrophied globe, especially one in which the cornea is preserved. Even after enucleation, the wearing of an artificial eye has, in rare cases, given rise to sympathetic developments that have subsided soon after discontinuing its use. In many hundred cases I have never seen this result, nor have I ever lost a patient from the removal of the eye.

The operation of enucleation is very simple. The instruments required are a pair of strabismus scissors (Fig. 875), one or two strabismus hooks (Fig. 874), a pair of toothed forceps, a stop speculum (Fig. 860), and a pair of stout, blunt-pointed scissors, curved sharply on the flat. An assistant must be ready with a few soft, clean sponges. As to anæsthetics, I generally give them, but often operate without, where the patient prefers it and has good self-control. The operation is a little more tedious and painful than a tenotomy, but can be easily borne without ether. The patient, whether under ether or not, should lie on the back and be kept quiet if possible. The speculum introduced, the conjunctiva is seized near the cornea, raised, and rapidly divided close around the cornea. After the first incision a strabismus hook may be passed rapidly round the cornea under the conjunctiva, raising and making it tense so that the scissors may divide it regularly and quickly. This done, the forceps pick up the conjunctiva above, while the scissors detach it over the insertion of the superior rectus. The hook is slid under and the tendon severed close to the sclera. The same is then quickly done for the three other recti tendons. The speculum is now removed, and the eyeball sprung between the lids, which are pushed back. If any trouble is experienced in this manœuvre, it is due to the fact that a tendon may partially or completely have escaped division, or that the globe is too large to pass the commissure. In the latter case, the stout, curved scissors, closed and passed behind the globe, may aid in prying it forward. This done, the index finger of the left hand is passed in behind the globe, springing it more forwards, and rendering the optic nerve tense. The nerve is thus felt and held securely by the index finger which guides the scissors, introduced from the opposite side. They are passed in, closed, till the point is felt by the finger. Then opening and pushing them a little further, the nerve is snipped off between the finger and the sclera. It is hardly possible in this way to fail in severing the nerve at once. It yields with a jerk, and the ball, coming forwards, is seized by the left hand, drawn out, and the two oblique muscles detached with the scissors, using great care not to cut the lids in this last act. The moment the eye is removed I plunge the left index to the apex of the orbit, and make rather firm pressure for a few minutes, stopping the hemorrhage at once. That done, a folded wet compress is placed over the closed lids, and a bandage tightly applied. Usually the loss of blood is next to nothing, and I have had serious hemorrhage in but two cases. These were both in old people, and in both the bleeding was readily controlled by the finger passed firmly into the orbit. No sponge, cotton, or anything but the finger, should ever be inserted into the orbit.

TREATMENT OF WOUNDS OF THE EYEBALL.—An incised, or even a lacerated wound of the *conjunctiva*, alone, very soon heals. When it is extensive, the edges should be well united with stitches. Even when a considerable portion is carried away, it slides and stretches so readily that the denuded surface is easily covered, as is done after the removal of a pterygium. The operation of syndectomy (removing a large zone of conjunctiva from the eyeball, immediately around the cornea), sometimes practised for the relief of obstinate pannus and other diseases of the cornea, shows how extensive a surface may be covered in this manner. The same is true of the extensive removal of the reflected portions of the conjunctiva, as a mode of treating granular eyelids, gravely proposed and executed by a French oculist. I cannot believe, however, that such operations are justifiable, knowing the many disadvantages which result from the great contraction of the conjunctival surface that must follow. The restraints in moving the eyes resulting from the marked symblepharon, and the inevitable dryness from impaired secretion, are not compensated for by the ends obtained. All surgeons know the serious and incurable lesions of the conjunctiva and lids, resulting from destruction of granulations by caustics. These facts should guide us in saving all the conjunctiva possible in wounds and burns of that important membrane. Very serious after-effects may follow wounds and losses of conjunctiva at the inner commissure of the lids. The cutting off or tearing away of a canaliculus by a wound, gives rise to the most troublesome and often hopeless weeping, so that, if possible, this complication should be recognized and overcome by careful use of stitches, so that the permeability of the canaliculus may be restored. Burns in this region, for the same reason, are very serious, and often lead to epiphora, entropium, trichiasis, and an endless train of troublesome consequences. Indeed, burns of the eye and lids, especially when extensive and deep, are most disastrous. The reaction follows very slowly, so that the prospects at first look hopeful; but in a few weeks severe and persistent inflammation sets in, leading to uncontrollable adhesions between the lids and the ball, to opacities and perhaps perforation of the cornea, and to other lesions. One cannot be too guarded in the prognosis of such cases. Consequences inevitable from the first, are apt to be put down to the credit of faulty treatment. Wounds of the conjunctiva, when properly dressed, need no local remedies but weak detergents. No astringents or painful applications must be allowed. Of course, conjunctival wounds often exist as an important complication of other deeper and more serious injuries, which then command the chief attention. If a muscle be severed, or the sclera penetrated, or if a deep wound of the socket be present, these become objects of solicitude. Should a foreign body hang in the conjunctiva, or be lodged under it, diligent search must be made in order to its speedy removal. Sometimes, when a small piece of steel or other substance has passed under the conjunctiva, it can only be removed by firm seizure with forceps and snipping away a small portion of the membrane with it. Should a wound of the conjunctiva exist with a more or less serious injury of the lid or lids, the proper and exact adjustment of the margins of the wound is the chief point to be secured. The presence and seat of a wound of the lid, or its entire absence, are often valuable aids in the diagnosis and treatment of injuries of the eye, of whatever kind.

The treatment of injuries of the *cornea* depends much upon the complications. If perforation have not occurred, and the wound be not contused, simple cleansing, followed by quiet, closure of the lids, and cold applications, or a comfortable bandage for a few hours or days, is all that is required. If the chamber has been opened, the sudden spirting of aqueous will nearly always produce hernia of the iris. This should be reduced, if possible, but it can only be done during the first few hours. Plastic exudation soon takes place, and so glues the protruding iris in the wound that it cannot be returned. If the prolapsus is small and quite recent, involving only a small portion, if any, of the pupillary margin, the prompt and energetic use of eserine may reduce it completely. Rarely is it safe or advisable to try to return it by a spatula or other instrument. If the herniated iris cannot be relieved, the next best thing is to remove as much of it from the wound as possible. This requires much delicacy and coolness on the part of the surgeon. If the patient has great self-control, anæsthesia is not required, but otherwise it must be complete. If the prolapsus is at all prominent, it can be clipped off with scissors pressed well against the cornea. If ever so little of the pigmented iris is snipped away, the aqueous trickles or spirts out, and the prominence at once disappears. Should this plan not succeed, the imprisoned iris must be seized with small iris forceps, drawn gently and carefully out, and snipped close to the corneal surface with the scissors. Great caution is here required in preventing any sudden rotation of the eye, which is almost certain to occur if the patient be not unconscious. The iris is most acutely painful when seized, and, if the patient roll the eye suddenly, the whole or a large part of this membrane may be dragged loose from its insertion. Von Graefe relates a case in which the entire iris was removed from the eye by such an accident, and I have seen such an occurrence in other hands. When the eye is perfectly still, and the iris is drawn tense, and snipped quickly and close, no such accident can take place. It is of vast importance for the future of the eye, to remove every trace of iris from the wound. Otherwise, staphylomatous protrusion of the cornea, glaucomatous hardness, and slow but hopeless loss of vision may be the result. If with the corneal perforation and hernia of the iris, there be, at the same time, injury of the *lens capsule* and cataract, the danger of violent reaction is greatly increased. The rapid swelling of the traumatic cataract leads to pressure upon the iris, increased intra-ocular tension, pain, and perhaps panophthalmitis. The first thing to be done is to free the corneal wound from iris, as above directed, and then to dilate the pupil and keep it dilated by instillations of atropia, four grains to the ounce of water, dropped in several times a day. The dilatation draws the pupil away from the irritating lens substance, and helps to control iritis and the tendency to closure of the pupil. If the lens swell so rapidly that large masses protrude through the rent in the capsule, it may be best to remove it by a linear incision in the cornea, or by opening, and perhaps enlarging, the original corneal wound. But if the patient is young, the absorbents active, and the pain and increase of tension not great, this may not be necessary. In that case, or after removal of all the soft lens substance that can be readily let out, the patient should be put quietly to bed, and ice-cold compresses, renewed often and kept up day and night, should be used till the reaction is controlled. It is next to certain, however, that at best the eye will recover with secondary cataract, adhesions of the iris, and little or no useful sight. But the patient is saved from protracted suffering, hopeless loss of sight, and the danger, immediate and remote, of sympathetic ophthalmia in the other eye. By prompt and skilful treatment, an eye may be saved and made useful at a later period by an iridectomy. Of course, if with all the lesions already described, a foreign body be lodged in the lens, it must be removed with as much of the lens as possible. If an iridectomy can aid in its removal, this should be employed, and will, perhaps, help to save the eye. Should the foreign body have traversed the lens and lodged deep in the eye, it cannot be removed, and the sight will be lost, with great danger of sympathetic trouble in the fellow. In such a case, immediate enucleation may be advisable.

If a limited contusion of the cornea, without perforation or rupture of the globe, has occurred, the immediate reaction may be slight, but very destructive consequences are likely to follow.[1]

Wounds of the cornea proper are not as dangerous to sight, even with the serious complications mentioned, as injuries of the same kind at the *sclero-corneal junction.* If the aqueous and vitreous chambers have both been opened, there will not only be loss of vitreous and perhaps intra-ocular hemorrhage, but prolapsus of the iris and of the ciliary circle. A careful removal, if possible, of any foreign body from the wound and the eye, must be followed by snipping the iris from the corneal wound, and clipping off the protruding vitreous, so as to secure the very best coaptation. It is seldom advisable to use a stitch except for the conjunctiva. If extensive wounds of this critical region be complicated by intra-ocular hemorrhage, and the presence of a foreign body that cannot be reached, immediate enucleation is the shortest and safest way out of difficulty. Lately, a few successful cases have been reported of removal of pieces of steel from the eye by aid of a magnet. In the great majority of instances this plan fails, but it is sometimes worth a trial. In wounds of the *sclera*, not involving the ciliary region, a stitch or two, embracing the ocular conjunctiva and the superficial tissues of the sclera, may be resorted to with advantage. In extensive rupture of the sclera, parallel to the corneal margin, with perhaps complete loss of the lens and escape of vitreous, little can be done but to cleanse the wound and apply a bandage for a few days or weeks. Such ruptures are not apt to be followed by violent reaction or sympathetic danger, and sometimes get well with useful vision. If the lens has escaped and lodged under the conjunctiva, this membrane must be incised and the lens removed. In case of *concussion of the eye*, without rupture or wound, the lens may be luxated, and may become, as it nearly always does, a serious source of irritation and danger. If it has been knocked through the pupil into the anterior chamber, it must be carefully extracted. If displaced to one side, behind the iris, it is very liable to give rise to irritation and secondary glaucoma, with pain and total blindness. In that case, if it cannot be safely extracted, the eye should be enucleated in order to save suffering and place the other eye in a condition of safety. An operation for the removal of such a lens involves grave difficulties and risks. Still, it can sometimes be successfully done, and the eye saved. Should a small *foreign body*, driven with force, penetrate deep into and remain in the eye, with only partial impairment of sight, what is the wisest course to pursue? If it cannot be removed by the magnet, it may be safe and wise to keep the patient quietly under observation for some weeks or months, to see if it will be tolerated. It may become encysted in the vitreous, retina, or choroid, and may remain harmless. But such eyes are always a source of solicitude to the experienced surgeon, and may suddenly develop trouble, at any time. If fixed in the ciliary region, the foreign body will almost certainly give rise to inflammation and sympathetic danger. When forbearance ceases to be safe for the patient, enucleation must be resorted to.

Of all foreign bodies lodged in the eye, a shot is more likely to remain harmless than anything else. I recall three cases in which both eyes were destroyed by shot. One patient had extensive intra-ocular hemorrhages, followed by cataract, but never suffered any severe pain, and the eyes were preserved with a plump, healthy appearance. The second patient I saw but once, and never heard of afterwards, while the case of the third presented some interesting features:—

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[1] See hypopium keratitis, page 228.

A boy, 12 years old, received a discharge of bird shot in the face, and was instantly blinded. The accident occurred September 29, 1881, and I saw him one week afterwards. A shot had penetrated the right eye through the ciliary region, near the inner margin of the cornea. In the left, another had entered through the cornea, near its edge, and had traversed the iris and lens, producing traumatic cataract. The lens was finally absorbed, leaving a clear pupil, with some vision, and perception of colors. The eye is normal in size, tension, and appearance. In the right, chronic cyclitis and atrophy of the globe followed. But this eye, even, is now quite comfortable.

If a shot has entered the eye anywhere in front of the equator, the round discolored point of penetration can always be detected. (Plate XXVII., Fig. 6.)

Concussion of the eye often leads to serious and permanent injury to sight. In many cases, rupture of the lens capsule is detected, and of course traumatic cataract follows. In others, no rent in the capsule can be discovered, but cataract ensues, probably from loosening of the lens from its intra-capsular connections.

In other instances, no gross lesions can be discovered to account for the damaged sight. There must be some molecular disturbances in the rods and cones, but they are not appreciable by the ophthalmoscope. Sometimes hemorrhages into the vitreous are found, and not infrequently genuine ruptures of the choroid. These are usually crescentic in shape, with concavity towards the optic disk. (Plate XXVIII., Figs. 1 and 3.) These lesions are always connected with serious damage to vision, from necessary injury to the percipient elements of the retina. The rule is that suppurative inflammation follows the penetration of a foreign body, whether the latter lodge in the eye or not. In rare exceptions little inflammation ensues, and in some none at all. Why this great difference, in apparently the same circumstances? It has usually been attributed to difference of individual toleration, due to temperament and idiosyncrasy.

In the recent researches of Lebert and others, the germ theory seems to afford an explanation. By experiments with animals, and observations drawn from large numbers of published cases in men, he has come to the following conclusions: (1) The simple presence of a pure and chemically indifferent foreign body in the eye, excites no inflammation. (2) Aseptic foreign bodies, of metals which oxidize, do not give rise to suppurative inflammation, but cause trouble, especially when large and in the vitreous, giving rise to detachment of the retina, etc., from chemical reactions. (3) Suppurative inflammation always follows, if the wound is infected by germs of lower organisms that rapidly multiply in the wound and around the foreign body. Suppurative inflammation can come from chemical irritation, but if no germs are present, usually does not. (4) The suppurative inflammation, after injuries, from the growth of microbes, is caused by the chemical substances eliminated by their growth, as is the inflammation complicating cysticercus cellulosæ in the eye. The chemically indifferent foreign bodies, are particles of stone, glass, splinters of wood, eyelashes, gold wire, and lead, when free from germs.

In a brief note just published, Lebert adds the following: (1) Aseptic pieces of copper, unlike those of iron and steel, when lodged in the anterior chamber, excite suppurative inflammation only when in contact with the iris, but not when sticking in the lens, and projecting into the anterior chamber. (2) If the piece of copper is suspended in the vitreous humor, suppurative inflammation does not follow. When resting in the tunics of the eye, in the ciliary region, suppuration ensues, but is limited to the immediate neighborhood of the foreign body. (3) Lead wire does not excite suppuration, either in the vitreous or in the anterior chamber. But small masses of lead, suspended in the vitreous, give rise to the same form of detachment of the retina as iron or copper. (4) Metallic mercury, introduced aseptically, develops, both in the vitreous and anterior chamber, severe suppurative inflammation; but this differs from the inflammation produced by rapid germ development, by not extending to the neighboring parts of the eye. These results refer, of course, to experiments on the eyes of animals.

Diseases of the Conjunctiva.

The known frequency of these affections is in part explained by the constant contact of the air, and of all it contains, with the conjunctiva. Not only floating particles, but poisonous vapors thus reach its sensitive surface, and give rise to irritation and inflammation. The easy access of contagious secretions, also, gives a rational explanation of the origin of many of these maladies, while the influence of atmospheric changes in exciting diseases of this portion of the mucous membrane, is likewise well established.

Conjunctivitis.—By far the greater number of morbid processes involving the conjunctiva are of an inflammatory character, and we naturally begin, therefore, with the *symptoms* of conjunctivitis, and first, the *objective symptoms.* These are: (1) Increased injection, ranging from the slightest blush to the most vivid redness. (2) Swelling, due to inflammatory hyperæmia and infiltration of the tissues, but more especially of the subconjunctival structures. High degrees of this swelling, when involving the ocular conjunctiva, are called *chemosis.* Chemosis may be *serous*, of a watery appearance, yielding readily to slight pressure, and indicating less severity of inflammation; or *phlegmonous*, firmer, more opaque, tenderer to pressure, and evidencing more violent inflammation. (3) Perverted and increased secretion. This change varies from a slight excess of transparent mucus, through the muco-purulent form, to the most marked and profuse purulent discharge. The mild forms of conjunctivitis are usually transient, and attended by little danger. The phlegmonous and purulent varieties are apt to be disastrous in their consequences. They are, however, but degrees of the same process.

The *subjective evidences* of conjunctivitis are, a sense of dryness, itching, burning, and a feeling of sand in the eyes. Severe pain is not present except in violent forms of the disease, and then arouses fears of trouble in the cornea or the iris. Cloudiness of vision, and rainbow-colors around objects, are due to flakes of mucus on the cornea, and disappear by washing the eyes. Constant deficiency of sight generally results from morbid changes in the epithelium or other structures of the cornea.

The *diagnosis* of conjunctivitis is very easy, but the ready recognition of serious complications is not so simple. Therein are manifested the skill and success of the expert.

Prognosis.—The tendency of conjunctivitis, as of most other diseases, is to recovery. Under favorable circumstances it is apt to get well spontaneously. Aggravated by injudicious treatment or bad surroundings, or both, it becomes tedious and dangerous to sight. When recovery is spontaneous, or hastened by mild treatment, the conjunctiva is restored to its physiological condition, even in the most alarming, purulent form of the malady. As far, then, as the integrity of the membrane itself is concerned, the prognosis is always favorable. It is only in chronic cases, complicated by granular lids, that serious lesions of the conjunctiva itself are produced. The dangers of conjunctivitis are, immediately, to the cornea and iris, and, remotely, that of the formation of granulations and of their endless duration and consequences. The things to be most feared in every case of severe or protracted conjunctivitis, are implication of the cornea and more or less serious damage to its transparency.

Varieties of Conjunctivitis.—The marked characteristics of some forms of conjunctivitis have led to their separation and special designation, under the names of *simple*, *catarrhal*, *purulent*, and *phlyctenular conjunctivitis*. The first is mild, of short duration, attended by little secretion, and causing but slight inconvenience. The second is more serious, lasting longer, giving rise to more annoyance, and being attended by greater secretion of mucus. The third is the most acute, painful, and dangerous to the integrity of the eye, its diagnostic symptom, indicated by the name, being a profuse discharge of pus. A form of purulent conjunctivitis rarely seen in this country, but very destructive to sight, is called *diphtheritic*. In it there is at first no purulent discharge, but a plastic infiltration of all the tissues, strangulation of the blood-vessels, and usually destruction of one or both corneæ. *Croupy* conjunctivitis, where the deposit is superficial, and can be peeled off, is much less serious. The *phlyctenular* variety is limited to definite parts of the conjunctiva, and, as the name implies, is known by the formation of little elevations or phlyctenulæ, the favorite seat of which is the ocular conjunctiva, near the cornea. They vary in number from one or two to many more, in bad cases surrounding the entire cornea. Each is a focus for well-defined local injection, the rest of the membrane often being quite free from redness. In the mild cases there is little secretion and no intolerance of light. When the isolated phlyctenulæ are more numerous, the patches of inflammation become confluent, the secretion of mucus is more free, and the symptoms are those of acute, catarrhal conjunctivitis. The diagnostic lesion is the well-marked phlyctenula. This peculiar inflammation occurs nearly always in children with the scrofulous diathesis. The same little patients often suffer at intervals with blepharitis ciliaris, scabby eruptions in and around the nose, on the skin of the lids, behind the ears, and on the scalp, with enlarged lymphatic glands, hypertrophied tonsils, and other strumous manifestations. The disease seldom occurs in adults, except in such as have had it, at times, from childhood. When the phlyctenulæ are seated on the cornea, they give rise to more serious and protracted suffering, and often leave the eye damaged in sight from corneal opacities. The disease is then called phlyctenular keratitis, but it differs in nothing, save in the seat of the lesion, from phlyctenular conjunctivitis. The chief disease of the eyes in infancy is purulent conjunctivitis; that of childhood, phlyctenular conjunctivitis. The healthiest infant may have the one, but only the scrofulous child the other.

Etiology of Conjunctivitis.—It would seem that all the varieties just described may recognize the same causes, the very different symptoms depending on the peculiar constitution of the patient, his immediate surroundings, or a difference in the directness and intensity of the cause. For instance, a catarrhal conjunctivitis, due to atmospheric causes, may be aggravated by bad ventilation, filthy habits, and constant reckless exposure, into the purulent form, with its destructive tendencies. On the other hand, the simple, the catarrhal, and the purulent varieties, may often be traced to the same contagion. Atmospheric vicissitudes acting on a strumous child, will probably give rise to phlyctenular conjunctivitis, while in the adult and non-scrofulous, the catarrhal variety will follow; or if the cause act with sufficient intensity, aggravated by bad health and surroundings, purulent conjunctivitis may result, with all its characteristics. While these are established facts, doubtless by far the most frequent cause of purulent conjunctivitis is contagion. To the eyes of the infant it comes from the genital organs of the mother, during parturition. In the adult, it is the result of self-inoculation with gonorrhœal matter. The contagion may get into both eyes at, or about, the same time. But frequently the second eye contracts the disease from the secretions of the first. Without careful supervision this is almost certain to occur, when only one eye is at first involved. To prevent inoculation of the second eye from the first attacked, is much more difficult in infants than in adults. Because an infant is attacked by severe purulent conjunctivitis soon after birth, we are not justified in assuming, necessarily, that the mother has gonorrhœa. Simple leucorrhœa, the lochia, and even the liquor amnii, getting into the eyes, may give rise to purulent conjunctivitis. Certain atmospheric or other conditions sometimes predispose to the more ready and rapid spread of the contagion of this disease, causing it to assume an epidemic form. At such times, it is not always easy to trace the contagion where it actually has taken place; and sometimes inflammatory conjunctival diseases arise without contagion, and, when reaching a certain suppurative degree, are communicated to others. In badly ventilated asylums, school-houses, barracks, and tenement houses, where large numbers of persons are crowded together, especially at night, the conjunctiva becomes so irritable, and takes on violent disease from such slight causes, that the destructive spread of conjunctivitis can only be prevented by breaking up the dens of infection, and isolating the diseased persons. Isolation, cleanliness, fresh air, and healthy food must be secured, if the disease is to be cured or prevented from spreading.

Ophthalmia neonatorum, the scourge of the lying-in room in all ages, is now so well understood by educated physicians, that its occurrence can be nearly always prevented by timely precautions. I have insisted for many years, in my lectures, on the importance of promptly washing off the face and eyelids and washing out the eyes of every new-born babe, with clean tepid water, before bathing its body. The additional precaution of dropping a solution of nitrate of silver into the eyes, twice a day, for the first day or two after birth, will certainly save the child from purulent conjunctivitis, and from possible blindness of one or both eyes. A two-per-cent. solution is quite strong enough, and causes, even when freely dropped into the eyes, no serious irritation. A weak solution of carbolic acid, or a stronger one of boracic acid, will answer the same purpose, but the nitrate is found to be the surest preventive. The adoption of these wise precautions in most hospitals and lying-in establishments, has recently settled beyond cavil the preventability of this dangerous affection. The same remedies, at once applied, in adults where known contact has taken place by accident or carelessness, will remove or destroy the virus, and save the eye from a frightful attack of purulent conjunctivitis.

Treatment of Conjunctivitis.—Remembering the tendency to spontaneous and safe recovery in mild cases, and the great danger of inflammation of the cornea and damage to sight in severe attacks, our therapeutics will be rational. In times past, when every inflammation of the eyes was "sore eyes"—and when nitrate of silver, in substance or strong solution, was the invariable remedy—the doctor with his *lapis infernalis* was dreaded as the fiery fiend, ready to burn out the eyes! and he seldom failed!

In slight forms of *catarrhal conjunctivitis*, a few days of rest in a well-ventilated but sufficiently warmed room, some restriction of diet, gentle laxatives, and occasional bathing of the closed eyes with fresh, cool water, even without any topical treatment with astringents, will lead to a cure. If there is much secretion, and gluing of the eyelids during sleep, a little pure vaseline, fresh butter, or lard, rubbed on the lids at bedtime, will add much to the patient's comfort. In addition, a solution of five grains to the ounce, of boracic acid or biborate of sodium, dropped freely into the eyes, night and morning, will expedite the cure. A very weak solution of other astringents, such as sulphate of zinc or copper, or nitrate of silver, one-half grain to the ounce, used in the same way, will hasten recovery. If, in spite of this mild and proper treatment, the disease persists beyond a few days, with sponginess of the conjunctiva, and more free secretion of mucus, the carefully everted conjunctiva may be quickly and lightly brushed with a solution of five grains to the ounce, of nitrate of silver, immediately washed off thoroughly with cool water. The crystal or solution of sulphate of copper may be used in the same way. This brushing should not be applied more than once a day, and with great discrimination, keeping up the milder applications in the intervals. As the symptoms subside, the remedies should be applied more lightly and less frequently, till the patient is quite well. Of course, reading or close use of the eyes, or exposure to wind, dust, smoke, and such irritants, must be forbidden. There is a form of hyperæmia of the conjunctiva, but generally with little or no secretion, which persists in a chronic way, and which is not improved, but aggravated, by astringents, strong or weak, and which is often treated by inexperienced persons as granular lids. It is the congestion due to necessary strain of the accommodation in hyperopic and astigmatic patients. Correct this strain by the use of appropriate glasses, and the conjunctival redness disappears spontaneously. This probable complication, in the treatment of all chronic, persistent cases of conjunctivitis or of blepharitis, should never be forgotten.

The local treatment of *phlyctenular* or *strumous conjunctivitis*, is the same as that already described, with the addition of certain mercurial applications known to have a happy effect in dissipating the phlyctenulæ. A little pure and finely powdered calomel may be dusted upon the eye once a day, bringing it in contact with each phlyctenula if possible. A dry camel's hair brush may be dipped into the powder, and a little quickly sent into the eye by tapping the brush with the finger. The surgeon will soon learn the knack of doing this before the patient can wink. The same thing may be accomplished by using a salve once a day. One grain of calomel with a drachm of vaseline or lard, well rubbed together, causes very little irritation, when a small piece from the end of a probe is put in the eye by everting the lower lid. The dust or the salve should be used once a day, and continued for some days after the phlyctenulæ have vanished, to prevent the formation of others. Relapse is the tendency in this disease, and can only be permanently overcome by the use of constitutional, antistrumous remedies. Quinine in tonic doses, iodide of iron, the hypophosphites, cod-liver oil, good nutritious food at regular meals, great attention to the skin, and daily out-door exercise in the pure air, kept up faithfully for months, and even years, will not only help to cure the disease, but will fortify the little patient against many others of the same fatal class.

Treatment of Purulent Conjunctivitis in Infants.—No disease yields more readily to prompt and judicious treatment than ophthalmia neonatorum, and none is more dangerous to sight when neglected or badly treated. Constant cleanliness, day and night, must be observed throughout. The irritating pus must not be allowed to stand in the eyes, but must be frequently removed with great gentleness, so as not to scratch or abrade the corneal epithelium. No syringing is safe for the eye or the operator, and the eyes should not often be wet or washed with water. Absorbent cotton furnishes by far the best means of mopping and cleansing the eyes. The lids should be gently but well separated once an hour, or oftener if the secretion be excessive, and the matter that escapes should be rubbed off with the cotton and thrown into the fire. This can be so lightly done as not to waken the infant, and the treatment must be rigidly kept up as long as the purulent discharge persists. Two or three times a day, the eyes should be well washed with tepid water. Infants are extremely sensitive to cold water. At each cleansing, or at least once an hour, a few drops of a solution of boracic acid, five grains to one ounce, should be dropped into the eyes, and the lids drawn open so that it may reach the whole suppurating surface. It causes little or no irritation, acts as an astringent, and perhaps destroys the micrococci and their germs. An equally safe and still more efficient remedy is the nitrate of silver, half a grain to one ounce, used with the same thoroughness and frequency. A solution of alum, one grain to one ounce, may be applied in the same way. Once a day, after the suppuration is frankly established, I evert the lids fully and carefully, and pencil them with a solution of nitrate of silver, from five to ten grains to one ounce, taking great care to prevent its running over the cornea. When the lids are everted and held securely, their natural spasmodic closure will fully evert the retro-bulbar folds, and will protect the cornea from the contact of the fluid. Waiting a second or two till the brushed surface becomes whitish, tepid water must be freely used to wash off the excess of fluid before returning the lids. In this way no harm can come to the cornea, and the suppuration can be very promptly and rapidly controlled. I always expect the child to be brought back the next day after the first brushing, very much better. Once a day is usually often enough for this treatment, keeping up the cleansing and use of weak washes in the intervals. But even with simple cleansing and the daily brushings, without any other medication, these cases get rapidly well in from one to three weeks. I cannot recall a single case in which ulceration and serious damage to the cornea have ever been witnessed, under this course of treatment, when the cornea has been intact at the beginning. Whatever theory may be adopted as to the pathology of this affection, all who have tested the nitrate-of-silver treatment fairly, agree as to its efficacy. Purulent conjunctivitis is a self-limited disease, but persists much longer under cleansing and milder treatment than under that which I have advised. As danger to the cornea exists during the whole suppurative period, the more quickly it is cut short, the sooner is the danger over. As the swelling and suppuration subside, the intervals between the pencillings may be prolonged. Firmness, but delicacy, of manipulation, in everting the lids and in safely applying the remedy, can only be acquired by experience. The child should be laid backwards across the nurse's lap, with its head held firmly between the surgeon's knees, face upward, the water, medicine, and all the needed implements being at hand. No instrument is required to evert the lids.

Treatment of Purulent Conjunctivitis in Adults.—It will be admitted, I think, that with the same management, or mismanagement, a larger number of adults than of infants will be blinded by this disease. The older and more decrepit the subject, the greater the danger to the cornea and to sight. With grown persons, I insist that they shall be put to bed and kept there till well. In the very onset of the disease, I begin the constant use of iced compresses. These must be changed, day and night, every ten or fifteen minutes, and continued till the pain, soreness, swelling, and violence of the disease are under thorough control. Then they may be intermitted for a few hours in the day, and in the night. Constant and careful removal of the matter from the eyes, as with infants, is of the greatest importance. As soon as the suppuration is fairly established, a weak solution of boracic acid, or of nitrate of silver, the same as in infants, should be freely dropped into the eyes every hour or oftener. If there is great phlegmonous swelling of the lids, chemosis, and dangerous pressure around the cornea, the external commissure of the lids may be freely divided, and light scarifications of the conjunctiva resorted to. Leeches to the temple or side of the nose may be ordered, but their effect is too slow to be greatly relied upon. The free incision of the commissure takes the blood more quickly, and directly relieves the pressure of the lids on the chemosed eyeball. A free purgative in the beginning, some restriction of diet, and opiates to relieve pain and promote sleep, are usually required. In the course of a few days, when the swollen lids and eyes are not so very tender to pressure, and the lids can be fully everted without much suffering, especially if the suppuration be profuse, the lids should be turned and pencilled once a day, as in infants. But while in the latter this may safely be done from the start, in adults we must wait a few days for the above changes to take place; then this more heroic local treatment is safer, rapidly controlling the disease, and abridging the period of danger.

Conjunctivitis Granulosa; Granular Lids; Trachoma.—Any one of the forms of conjunctivitis which have been described above, becoming chronic, is liable to lead to anatomical lesions of the conjunctiva, which, in general terms, are called granulations. In isolated cases, but chiefly in epidemics of conjunctivitis, these exuberant products are rapidly developed with very acute manifestations. The acute stage subsiding after a few weeks, the case runs on in a subacute and persistent form, and the granulations become the chief cause of danger, as well as the endless aim of treatment. An attempt has been made by Saemisch and others to establish an anatomical classification—*conjunctivitis folliculosa* and *conjunctivitis granulosa*—the former disappearing completely under mild, careful treatment, leaving no cicatricial lesion behind, and the latter always followed by more or less alteration in the anatomical texture of the conjunctiva. While it is true of rare forms of so-called follicular conjunctivitis, that they recover with perfect "restitutio in integrum," the two varieties are nearly always mixed, and the prognosis, therefore, is usually not so favorable. The distinction is further based upon differences in the distribution of the inflammatory infiltrations, the follicular being grouped in closed capsules under the epithelium, or else the lymphoid elements forming in groups without a limiting membrane. In the other, the *true* granulation, the elementary products are more diffused, and pervade the deeper textures. Microscopical anatomy may finally, with further investigation, become a basis of classification and an aid in treatment, but practically I agree with Goldzieher that "conjunctivitis granulosa" may be held to include all varieties, as they require the same treatment. In view of the fact that they are all contagious, very tedious in duration, and prone to frequent acute relapses, that they usually lead to permanent cicatricial changes in the conjunctiva and lids, and that they seem to yield best to the same course of treatment, I shall consider them all together.

Granular eyelids are the uniform result of conjunctivitis of some kind, either acute or chronic. Hence their etiology is that of conjunctivitis. There does not seem to be any specific granular virus, conveyed by contagious secretions, producing always the same condition, and spreading in no other way. Atmospheric changes, and anything that gives rise to colds, may be followed by conjunctivitis and granulations. Morbid secretions, either from diseased eyes or from the urethra, are the most frequent means of propagation, their greater or less purulence giving them more or less virulence.

Granular eyelids are the scourge of some countries, while in others they are scarcely known. The disease has made serious ravages in Belgium, Italy, and other countries of Europe, since its general introduction by the return of the French army from Egypt. Still, it has prevailed more or less extensively in most countries, before and since that event. It is much more likely to spread among the poor, and those whose habits are not cleanly, especially if they work hard and indulge in all sorts of irregularities and dissipations. The crowding together of large numbers of people in badly ventilated quarters, favors the grave character and spread of this dread disease. It prevails very largely among the farmers and laboring classes of all the Western States and territories, and, when it enters a family, is very apt to attack all its members and persist indefinitely.

The *diagnosis* is usually very easy, although many cases of simple hyperæmia of the conjunctiva, or chronic cases of conjunctivitis, are treated severely and during long months for supposed granulations. The rough, rugous, and often "cockscomb" appearance of the everted lids, and of the retro-bulbar folds, is recognized at once. In more recent and milder cases, where the inflammatory deposits are not so large, the surface is less rough and characteristic, but still a very little experience will prevent its being mistaken. In the reflected folds, the deposits are often more sharply isolated, roundish, and somewhat elevated, in rows with the folds, semi-transparent, like frogs' eggs, and but slightly vascular. With more violent inflammation, swelling, and redness, their individual peculiarities cannot be recognized. Granulations are confined mainly to the tarsal and reflected parts of the conjunctiva, but sometimes extend to the sclerotic portion, and even to the cornea. In some instances the hypertrophied structures and infiltrations, although seemingly enormous, are superficial, and disappear with little or no trace of cicatricial lesion. In others, apparently not as bad, the new deposits are deep and destructive to the conjunctiva and tarsus, and are followed by serious lesions, distortions of the lids, and such impaired functions as to make the eyes almost useless and a life-long trouble. Deep or untimely cauterizations increase the danger of serious organic lesions, and their disastrous effects upon vision. There is always, preceding and accompanying granulations, inflammation with its symptoms, perverted and increased secretion, and more or less suffering and functional disturbance of vision. The droopy and sleepy appearance of the eyelids in these cases is pathognomonic, and yet the diagnosis must be made sure by direct objective inspection of the entire conjunctiva. To this end it is necessary to evert the lids. If the patient does not shrink back from the surgeon, and will look firmly to the floor, it will be easy to turn the upper lid in the way already described (page 198). The lower conjunctival folds are readily exposed by drawing the lower lid down while the patient turns the eye upwards. Inspection of the cornea is secured by sliding the lids apart while the patient turns the eye down, avoiding eversion.

Treatment of Granular Conjunctivitis.—In a long and large experience with this disease, I find the main difficulty to be in keeping the inflammatory element under safe control. The proneness to acute relapses, each setting the patient back and retarding recovery, must never be lost sight of. By wise circumspection these may be prevented or cut short, so that at last they will cease to occur, and the patient will get well. Just here lies the difficulty of treating these patients at long range. They need to be seen daily, and kept under the closest supervision, for weeks, and months, and even years. If, after proper treatment for a few days or weeks, they feel better, they insist upon going home, promising to "carry out the same treatment." If no better, or worse, they despair and change doctors. So they go the rounds, and come back, if at all, always worse. If frankly told at the start that the treatment will be very long, and will require great watchfulness on both sides, they go to a more ignorant or less scrupulous surgeon, or to a brazen quack, who promises a certain and speedy cure. Such patients often try every silly thing they hear of, and express surprise, at last, that they do not get well! Peripatetic patients, with granular sore eyes, do not furnish good cases for a novice who wants to make a reputation. Great skill and eternal vigilance can alone guide to safe recovery. Ugly and fatal complications beset the long and crooked road that leads to relief, and few there be that walk wisely and patiently therein. The discriminating use of a few well-known remedies is the secret of successful treatment. The management of these cases must be very largely hygienic, as well as therapeutic. Cleanliness, great attention to the skin, diet, and clothing, exercise in the open air, rest of the eyes from close work, regular habits, temperance, and avoidance of all known causes of irritation, are conditions that must be enforced, otherwise no treatment can avail. Whatever conduces to the best health, is necessary to speedy recovery from any disease. If the farmer continues his laborious life, the student his studies, the good liver his fast ways, the intemperate his wild career, no science can save the eyes. The thorough obedience and coöperation of the patient must be secured. Except with free livers, restriction of diet and severe antiphlogistic treatment are not required, and are often injurious. Healthy, nutritious food at regular meals, orderly exercise in the open air, and a general course of tonics, are usually indicated.

The *local treatment* of granular lids is guided by two indications. The first, that of subduing the inflammatory reaction and keeping it within safe bounds. The second, that of producing temporary local stimulation, and thus promoting the slow and safe absorption of the morbid deposits. Their destruction by cauterization is not to be thought of. In the first stages of acute trachoma, and during the inflammatory relapses that are so troublesome and characteristic, local anodynes and soothing remedies alone are permissible. There is a natural tendency, under favorable surroundings, for the inflammation to subside after a few days or weeks. It should be allayed by mild treatment; not aggravated, prolonged, and rendered more dangerous to sight by violent applications. If tenderness to light, weeping, spasmodic closure of the lids, pain, and marked ciliary injection are present, the solution of atropia, four grains to the ounce, dropped in the eyes, from three to six times in twenty-four hours, is nearly always beneficial. The atropia instillation should be continued till these symptoms are overcome, abating its frequency as they subside. Cold-water bathing of the closed lids, at frequent intervals, in robust people, and during the acute stage, is grateful and useful.

The regular use of cold compresses, for a few hours at a time, helps to subdue the excessive local temperature. In the chronic stages, however, the acute relapses are often better controlled by warm fomentations that hasten the suppurative tendency, permitting astringents to be safely used. Moderate purgation once or twice a week, and opiates at night to ease pain and promote sleep, are valuable aids. Either from the start, or, better, after a few days, when the intolerance of light and weeping have given way to more or less mucous or muco-purulent secretion, a solution of boracic acid, five grains to the ounce, or of biborate of sodium of the same strength, may be dropped freely into the eyes three times a day. These solutions are somewhat astringent and scarcely at all irritating. To prevent painful adhesion of the lids at night, their edges may be greased with vaseline, fresh butter, or lard.

If keratitis sets in, as it is always prone to do, with abrasions of the epithelium, patches of infiltration, abscesses, and ulceration, the atropine should be applied oftener, and the other treatment kept up more rigidly. With this complication, and sometimes without it, acute iritis is apt to occur, with its characteristic circumorbital pains. In that event, the mydriatics are all the more important. It is in view of this complication, which seems to be favored by the local use of eserine, that I am cautious about the use of the latter for the purpose of preventing the destruction of the cornea. The boracic acid, cold, compression with a bandage, opiates, quinia, and careful paracentesis, are the remedies in which I have most confidence. Still, I sometimes use a drop of the eserine solution directly to the ulcerated cornea, once in six or eight hours, keeping up the predominating influence of the atropine all the time.

This gentle and rational course, continued for a few days or weeks, is likely to subdue the inflammatory troubles, so that very careful local stimulation may be tried. The tolerance of light, absence of tears, and presence of more or less mucous or purulent secretion, with fading away of the sclerotic injection around the cornea, *especially above*, are favorable symptoms. In proportion to the amount of pus contained in the discharges, and the succulence of the conjunctiva, will be the preferability of nitrate of silver over other astringents or caustics. We begin with a five-grain solution, brushed quickly and lightly over the thoroughly everted lids with a camel's hair pencil, and quickly washed off with water, so that none of it touches the cornea. In twenty-four hours, if the reaction has been brief and the eyes seem better, the application may be repeated in the same manner. Little by little we feel our way, and determine the tolerance of the eyes. While a solution of this strength does well, its use may be continued. When it ceases to produce sufficient reaction, the proportion of the nitrate should be increased to ten grains. Stronger solutions than this are seldom required, and are not safe. Alternating the local remedies is nearly always found beneficial. Use one a few days or weeks, as long as it does good; then resort to another; and finally you may return to the first substance used, with advantage. The sulphate of copper in solution, or in smooth crystal, is a valuable remedy, and for long-continued use is preferable to the nitrate of silver, which is likely to discolor the conjunctiva. A five, ten, or even twenty-grain solution may be brushed on once a day, and then be well washed off, but most surgeons use the crystal, passed quickly over once or twice, and then freely washed away. When the retro-bulbar folds are thickened, the crystal can be passed back under the upper edge of the everted tarsus, so as to reach them. In many chronic cases, it is found that the nuetral acetate of lead in saturated solution, and well washed away, acts very favorably and produces little reaction. It should never be used as a wash, dropped into the eyes, in such cases, for fear of precipitation in the cornea. Tannin, crystals of alum, and many other astringents have at different times been recommended, but if no one of the three remedies above described acts well, scarcely any other will. Of course the conditions that admit of safe local stimulation to encourage absorption, make the further use of atropine unnecessary. As it keeps the pupil dilated and paralyzes accommodation, thus causing great confusion of vision, and often alarm, it should only be used when decidedly indicated. In rare cases it produces atropinization and will not be tolerated at all. In these, hyoscyamine or duboisia must be substituted. Should an acute relapse occur during this course of judicious local treatment, as it is apt to do, drop the local irritants and return for a time to the soothing measures, and so with one or the other persevere to the end, which is nearly always far in the misty future.

In intractable cases of granular lids, with *pannus* covering and protecting the cornea, inoculation of gonorrhœal pus, first suggested by Friedrich Jaeger of Vienna, in 1812, has often been successfully practised. Brilliant results, in the most hopeless cases, have been published from time to time, and adverse criticism has always come from those who have never tried the remedy. In 1855, Warlomont published a paper in high praise of this heroic treatment, in extreme cases, especially where the corneæ of both eyes were covered by pannus. In 1857 I myself published a paper on the subject, with the history of a very successful case. As the patient could see a little with one eye, I inoculated only the bad one, sealing up the other and keeping it free. After the subsidence of the violent reaction, I left the other eye open purposely, although only the upper half of the cornea was vascularized. On the third day this eye was attacked, but less severely, and the disease passed its climax spontaneously on the fourth day. From this time the lids of both eyes were everted, and brushed with a twenty-grain solution of nitrate of silver, once a day for eight days, when all suppuration had ceased. The granulations, which were enormous, completely disappeared; the sight of both eyes was so far restored as to enable the patient to read; and the last news I had from him, twelve months afterwards, he was following a threshing machine. He left the hospital seven weeks after the inoculation of the first eye, and three weeks after that of the second. I treated a number of cases by this means, and most of them with prompt success. They were all what might be called almost hopeless. Afterwards, I tried it as a last resource in the case of a little boy. Both of the eyes were lost by ulceration of the cornea. In this case I hardly had any hope of success, but the granulations were cured, and the patient was soon comfortable. In a second paper (October, 1857), I said: "The more advanced the pannus, by which I mean the more completely the cornea is covered with vessels and exudation, the less danger is there in the treatment. If the vasculo-membranous layer covers the entire cornea, and is so thick that the pupil can scarcely be seen, if at all, then there is very little risk in the procedure, and you are almost sure to restore the patient's sight, provided that the true substance of the cornea is not the seat of an incurable leucoma." If the pannus is only partial, some parts of the cornea remaining clear, or if though general it is so thin that clear spaces are left between the vessels, through which the pupil is distinctly visible, then there is more danger to be apprehended from the application of the pus. The thick, pathological coating formed by the pannus protects the tissue of the cornea from the violence of the inflammation produced by the matter, and wherever such a protection does not exist, softening and sloughing, or ulceration, are liable to occur.

But my impression is, from what I have observed, that undue importance has been attached to the contra-indication afforded by the partial transparency of the cornea, for in one of the eyes which I treated thus, there were several portions of the organ that were merely slightly hazy, and traversed only here and there by minute vessels. At several points the pupil could be distinctly seen, and yet I allowed the inflammation to go on uninfluenced by treatment, and the cornea did not suffer the slightest injury. The great danger from gonorrhœal conjunctivitis, when it attacks a previously healthy eye, is sloughing of the cornea from the violence of the inflammatory reaction, and more especially, perhaps, from the strangulation caused by the pressure of the chemosis. Now, where there is a panniform condition of the organ, aside from the mere protection afforded by the new formation, it is much less likely to slough, because it is nourished by the new vessels, and the circulation in it is not so easily cut off by the swelling. For the same reason, we seldom see sloughing of the cornea to a large extent after it has become vascularized in acute keratitis. In a case of granular lids, then, with even a moderate number of vessels scattered over the cornea, though the pupil is visible through nearly every part of it, I think that there is no very great liability to ulceration, especially if the case be carefully watched and the inflammation promptly cut short on the first unfavorable symptom, as it almost certainly may be by the energetic application of nitrate of silver.

It is a rare thing for a well-informed ophthalmologist to lose an eye affected with gonorrhœal ophthalmia, if he sees it and treats it from the very commencement. Why, then, should he not be able to control the disease when artificially produced in an eye protected by a previous development of vessels? But experience alone can settle this question.

As to the *indications* for a resort to this treatment, they are few and simple. The first reason for inoculating a patient is that you have tried everything else, and have failed to cure him. After a fair experiment with the other agents recommended, if you fail to effect a cure, then you are certainly justifiable in essaying a measure that has rendered such signal services under similar circumstances. I say, after a *fair trial*, because I do not believe in waiting till the eyes are destroyed, or the corneæ so far disorganized that a cure is next to impossible. The sooner the remedy is applied, all things being favorable, the more likely we are to have a satisfactory issue. Patients may be cured in six weeks by inoculation, who would suffer for years, and perhaps never recover, under the ordinary treatment.

The same treatment, for the same reasons, has been more recently advocated by M. Ch. Abadie. His ability to control the violence of the reaction by brushing the everted lids twice a day with a ten-grain solution of nitrate of silver, prompts him to advise a more frequent resort to this therapeutic agent.

As an illustration of the thoroughness and promptness of this mode of treatment, as well as of its only danger, ulceration of the cornea, I give the following brief history:—

A very strumous lad, 17 years of age, came for treatment April 15, 1882. He was the victim of an acute attack of trachoma, of four weeks' duration. There was enormous thickening of the eyelids, lips, and nose. The granulations showed an exuberance such as I had seldom if ever seen. The right cornea was clear and intact, but the left showed some symptoms of superficial keratitis. He was treated for seven weeks, in the usual careful way, with some improvement. Early in June, he was taken with a violent purulent relapse which we could not certainly trace to inoculation. Taken at once to the Cincinnati Hospital, he was subjected to the most rigid treatment by Dr. S. C. Ayres. For two weeks, iced compresses were applied day and night. The lids were everted and brushed freely with a five-grain solution of nitrate of silver, twice a day, and were well washed off with water after each application. Both corneæ ulcerated in the centre, the ulceration on the left side ending in limited perforation with synechia anterior. On June 26, he went home much improved. In the beginning of September, he returned perfectly well. There were no traces of granulations, and but very small central opacities of the corneæ. On the 11th of December, he wrote that his eyes had slowly improved in sight, that he had had no back-set, and that he could read half an hour without fatigue; and he asked if he could safely go to school. This patient's general health was, and had ever been, wretched.

Quite recently, DeWecker has recommended the application of a watery solution of the seeds of the jequirity, as a safer substitute for inoculation. It is said to produce a milder form of suppuration from the conjunctiva, and to be equally efficient in its curative action. This remedy has long been in common use in Brazil in the treatment of "sore eyes."

In rare cases, after the lids have finally healed and have become as smooth as they ever can be, and when all distortions—trichiasis, phimosis, etc.—have been relieved by appropriate surgical measures, a chronic, vascular, relapsing keratitis may persist and require treatment. In these cases I have often succeeded well with finely powdered sulphate of copper. The upper lid is everted, once or twice a week, and a little of the powder applied by means of a moistened probe, and let down immediately on the cornea. A drop of the perchloride of iron may be used in the same way, allowing it to run over the cornea. The reaction following its application is intense for a few hours, but the benefit is often very prompt and great. In the same cases a solution of eserine may be used once a day. It seems at times to bring about a marked improvement in the pannus. Another remedy, which is very soothing and safe for the patient in home use, is a salve of vaseline and boracic acid, fifteen grains to one-half ounce, to be put in the eyes twice a day. Mercurial salves of different kinds, used in the eyes for granulations and pannus, are of no value in most cases, and positively injurious in many.

With one other practical remark, I end what I have to say upon this important subject. In the advanced stages of granulations, when the morbid deposits are undergoing slow absorption, and cicatrization is setting in, we often find, when the upper lid is well everted, that the acino-tubular glands, along the back edge of the tarsus, are engorged by a sort of gelatinous substance which keeps up the irritation of the cornea and delays the cure. For many years I have been in the habit of pressing this rudely out with the two thumb nails, one slid behind and the other in front, and moved along the whole length of the tarsus. This being well done two or three times, at intervals of a day or two, very much expedites the usual local treatment. This procedure is painful, but it must be adopted firmly and without hesitation.

Diseases of the Cornea.

Keratitis.—Inflammation of the cornea, in some form, is the starting point of most of its serious lesions. The clinical symptoms by which this process is diagnosed, are of easy recognition. Loss of the natural transparency is the first certain symptom. The degree of opacity may vary from the slightest haziness to the densest leucoma. With this physical change, is uniformly seen an alteration in the polish of the reflecting surface, giving it the appearance of ground glass, and causing images reflected from it to be blurred and indistinct. This depends on abrasions and irregularities of the corneal epithelium. With these objective alterations, there is associated the most characteristic subjective symptom, *photophobia*. The intolerance of light, in acute keratitis, is generally intense, particularly in scrofulous children. It is, however, by no means in proportion to the physical damage to the cornea and the degree of impairment of vision. The dread of light is often much more distressing than actual, severe pain. The latter may and often does occur, especially when there is infiltration and pressure on the nerve filaments of the cornea, or actual ulceration. In the latter case it is sharp and severe, like the thrust of a needle, but usually confined to the eyeball. With the photophobia is always very troublesome *epiphora*, and spasmodic closure of the lids. Of course the weeping is increased by exposure to light. When the eye is inspected, a more or less complete red zone of sclerotic injection will be seen around the cornea, fading out as it is followed toward the equator, which it does not reach. This group of symptoms is so characteristic that a mistake is scarcely possible. Blurring of vision, necessarily present, is not easily estimated, because the patient can open the eye but for a brief moment, and it instantly fills with tears. As the cornea performs a double function in the economy of vision, its lesions are all the more serious. With the sclera it constitutes the strong form-maintaining tunic, and, at the same time, it acts as a refracting medium. Faulty changes of curvature, giving rise to ill-defined images, and cloudiness leading to irregular and imperfect illumination, combine to make sight imperfect. Both changes are usual results of inflammation. Irregular bulging of the cornea in chronic keratitis, and softening and yielding of limited, infiltrated or ulcerated portions in the acute forms of the disease, are by no means uncommon. Keratitis may be primary or secondary. The first class embraces all forms beginning in and spending their main force upon the cornea. The second includes all cases in which the cornea becomes involved, as a complication, in the course of some other disease of the eye. Primary keratitis may result from purely local causes, or may be due to a dyscrasia, such as scrofula or syphilis.

The *etiology* of this affection is often difficult of discovery, and sometimes only conjectural. Even when traceable to a constitutional affection, it is not easy to explain why it occurs in some cases and not in others, or in one eye and not in both. There are local determining causes that are, as yet, inscrutable. Even in traumatic keratitis, including that from chemical action, the seriousness of the reaction varies very greatly in different cases, without our being able in all instances to ascertain the reason. Excepting traumatic cases, and those in strumous and syphilitic subjects, primary keratitis is of rare occurrence. The most frequent exciting causes of keratitis are atmospheric changes and impurities. Secondary keratitis is of very frequent occurrence, in the course of acute conjunctivitis. In purulent conjunctivitis, keratitis, with its consequences, is the great and only danger. In the simple form of inflammation of the conjunctiva, the invasion of the cornea begins at the margin. At first there is perhaps simple abrasion of the epithelium, and superficial ulceration close to and parallel with the margin, assuming a crescentic shape. This may go deeper and lead to marginal perforation, but generally the part undergoes vascularization, and then gets well. In purulent conjunctivitis the cornea is apt to be invaded in its centre, where its nutrition is most precarious. The attack may begin in the form of a limited abscess, followed by open ulceration, or by direct ulcerative invasion. In either case it is likely to lead to perforation, and to very serious damage to vision.

There is a form of inflammation of the cornea, peculiarly destructive in its tendency, frequently of traumatic but often of spontaneous origin, that is usually called *hypopium keratitis.* It might perhaps be better designated as *infectious.* It is nearly always seen in adults; often in stone masons, from contusions by fine pieces of stone; or in harvesters, from injuries by wheat beards. In these cases the injury seems slight and insignificant at first, and the severe reaction does not set in for two or three days. Those laboring under suppurative inflammation of the tear sac, are peculiarly liable to this trouble from slight wounds or abrasions of the cornea, or without any injury. The same source of local infection makes the extraction of cataract, in such persons, almost certainly destructive to the eye. This disease is characterized by rapid and limited infiltration, abscess, and ulceration, which is apt to spread both laterally and in depth, and which may lead to speedy perforation. A large portion or even the entire cornea may be thus destroyed in a few days. Very soon after the appearance of abscess and ulceration, an accumulation of pus is seen in the bottom of the anterior chamber, which increases, and may fill the entire chamber in a few days. The suffering is usually intense until perforation occurs, when it is apt to abate. In rare cases there is little pain or none at all. This disease always leads to permanent cicatricial opacity of the cornea and serious injury to sight, and in many cases to hopeless loss of vision. Its etiology, diagnostic symptoms, and treatment, are all somewhat peculiar.

Another variety, traceable often to hereditary syphilis, is called *parenchymatous keratitis.* It is seen nearly always in young persons of dwarfed appearance, and with the peculiar defect in the front teeth described by

Hutchinson.[1] Frequently there will be found nodes upon the shins, and other symptoms of tertiary syphilis. This disease is extremely persistent, leading to great cloudiness and vascularity of the cornea, and is often complicated by iritis and closure of the pupil. It nearly always attacks both eyes in succession. During its progress, or soon after its subsidence, a destructive inflammation of the cavity of the tympanum and labyrinth is liable to follow, terminating usually in total deafness.

Still another form of keratitis deserves special description. I mean the so-called *phlyctenular keratitis*, sometimes named *strumous*, because it nearly always attacks scrofulous, delicate, and precocious children. The pustule or pimple that gives it its peculiar name may be single or multiple, and situated anywhere on the cornea. It is usually small, and out of all proportion to the intense photophobia and suffering which attend it. The victims of this troublesome disease are likely to be afflicted by blepharitis ciliaris, phlyctenular conjunctivitis, otorrhœa, cutaneous eruptions about the face and scalp, enlargement of the lymphatic glands, and other scrofulous troubles. The seat of the phlyctenula makes all the difference possible in the symptoms. When on the conjunctiva of the sclerotic, it causes little suffering and soon gets well; but when seated on the cornea proper, extreme intolerance to light, spasm of the lids, and months of the most distressing suffering are likely to follow. The corneal phlyctenula sometimes ends in a small ulceration, and very rarely in perforation of the cornea with its consequences. The cornea is apt to become vascular, the little tuft of vessels running from the margin to the seat of the phlyctenula, and leaving after recovery often a corresponding band of opacity. In other cases there remains only a small speck of opacity, indicating the seat of the phlyctenula. The little sufferer is always worse in the morning, and better towards evening. Left to its instincts, the child will hide away in the darkest corner it can find, for weeks and for months; burying its face in the pillow, and holding its pale, bony fingers spasmodically on the eyes, fighting against the light with a deadly struggle. In warm weather the face will be soaked with sweat, the skin chafed and covered with eczematous patches, the eyelids fissured at the outer angles, and bleeding when pulled open, with scabs in and around the nose and behind the ears. This picture is graphic and pitiable, because true to nature. Photophobia, always a characteristic symptom of acute keratitis, is here most intense and persistent.

Variola is often followed by a severe and very troublesome form of keratitis. It comes on gradually, during desquamation, and results in great and permanent damage to sight. This form does not as often result in ulceration, perforation, and staphyloma of the cornea, as in dense opacity. It is always very obstinate, and requires an invigorating constitutional treatment. When *ulceration of the cornea*, under any circumstances, extends in depth, there is always serious danger of *perforation*. Mere perforation and loss of the aqueous humor, in itself, is not a dangerous termination. It is often to be desired and aided, rather than dreaded, as it is generally the turning point towards recovery. But if great care be not taken to avoid sudden perforation under pressure of the surgeon's fingers, or spasmodic contraction of the eyelids, a hernia of the iris will take place, with great increase in the immediate and remote danger to vision. As the cornea retains its natural curvature and position after loss of the aqueous, the lens is pushed forwards, carrying the iris before it, till its convex surface rests against the cornea and the anterior chamber is obliterated. If the perforation be large, sudden, and violent, not only extensive prolapsus of the iris may take place, but the capsule may burst, and the lens be extruded from the eye, followed by vitreous. This, of course, is destructive to vision. A hernia of the iris, however recent and limited, cannot often be reduced, even by the most prompt and skilful management. If not reduced, permanent distortion of the pupil, more or less damage to sight, and indelible opacity of the cornea with synechia anterior; danger of partial staphyloma of the cornea, of chronic glaucoma, and of hydrophthalmic enlargement of the eye; repeated relapses of iritis and choroiditis; and finally danger to the other eye from sympathetic ophthalmia, will follow. Hence the vast importance of preventing prolapsus and saving the eye with the least possible damage to the sight. If the perforation is limited and central, the iris is much less likely to prolapse than when the ulcer is seated at or near the periphery.

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[1] See Vol. II. page 565, Figs. 335–340.

There is likewise a form of keratitis called *neuro-paralytic*, due to paralysis of the sensory branches of the fifth pair of nerves. In this case the cornea becomes insensible to the touch, and does not feel the presence of foreign particles. Its surface becomes dry from long and unconscious exposure to the air; inflammation, sloughing, and ulceration take place; and the eye is rapidly destroyed. This disease is not as much, if at all, due to the trophic influence of the corneal nerves as to the cornea's unfelt exposure. In cases where the corneal sensibility is not entirely destroyed, the pain in this disease may be intense:—

On April 9, 1878, I was consulted by a lady, 54 years old, laboring under this disease of the cornea. When 19 years old she had had a "wen" removed from the left brow. It seems that the surgeon in stitching the skin injured the supra-orbital nerve, or one of its important branches. She felt it "all over her" at the instant. Total loss of feeling followed in the left forehead and eye. This lasted perhaps ten years, when partial sensibility returned and thus remained. There is now a linear cicatrix beginning 3 cm. from the median line, and 1 cm. above the brow, and running parallel with it. At the time of her visit she was suffering with severe pain in and around the eye, and a very distressing "feeling of numbness." Tension little, if at all, altered. She declared that the sight was abolished, but could not bear the use of the ophthalmoscope. There was a small ulcer a little outwards from the centre of the cornea, with some filamentous adhesions of the margins of the pupil to the lens capsule. The whole left side of the face and eye showed partial anæsthesia. I treated her with occasional use of atropia, compress and bandage, and repeated paracenteses of the cornea, making thirty in all, at intervals of one or two days. She recovered at last, with fair vision, and has continued well; but the imperfect feeling remains as before the attack of keratitis. A small crescentic opacity of the cornea, opposite the outer edge of the pupil, is all that remains visible now.

The destructive inflammation of the cornea that comes on in low cases of typhoid fever, with comatose symptoms, and in meningitis and other exhausting diseases which are nearing their fatal termination, is due to the same cause, and may be often prevented by keeping the eyes closed and moist. The same precautions should be taken to protect the eyes in their extreme protrusion in Basedow's disease, where sloughing of the cornea is the sad result in so many cases. Here it is due simply to inability to close the lids and protect the eye.

I have already described the corneal troubles which are due to conjunctivitis and to granular lids, and the lesions which so often follow.

Treatment of Keratitis.—First, let us consider those secondary forms that come on in the course of acute attacks of conjunctivitis. In severe cases of catarrhal conjunctivitis, with photophobia, weeping, ciliary injection, and more or less severe pain, this is the complication to be dreaded and guarded against. Sulphate of atropia, four grains to the ounce, should be freely dropped into the eye from three to six times a day. In robust subjects, cold compresses, often changed, and persevered in during the acute stage, are nearly always beneficial. Moderate purgation in the beginning, and full doses of anodynes at night, will aid greatly in controlling the disease. No astringent or irritating applications to the eyes should be allowed, as long as the intolerance of light, weeping, and ciliary injection, are at all pronounced. They always do harm, and greatly increase the danger to the integrity of the cornea. If the patient is feeble and anæmic, good nutritious diet and tonics are the safest constitutional remedies. In such persons warm applications are better borne, and dry absorbent cotton and the bandage, with occasional cleansing of the eyes, will be most grateful and satisfactory. When the local, anodyne, and other cooling and soothing treatment has been continued some days or weeks, till the dread of light, weeping, spasm of the lids, and all injection of the sclera, especially above the cornea, have passed away, then a change to prudent stimulation may be thought of. The patient now opens the eye in the light. It weeps little if any, and there is a more abundant secretion of mucus or muco-pus. Biborate of sodium five grains to the ounce, alum two grains, sulphate of zinc or sulphate of copper one-half grain, dropped into the eyes freely twice a day, will be well borne and will do good. A solution of boracic acid ten grains to the ounce, being unirritating, may be used earlier, or even from the start.

Should a relapse of keratitis occur, the employment of these astringents must be suspended, and the use of atropine, and other soothing remedies, must be recommenced. Should purulent infiltration and ulceration ensue, the atropine and boracic acid must be used more frequently. If ulceration take place, *near the margin of the cornea*, with threatened perforation, it is wise to omit the mydriatic in favor of eserine, to contract the pupil, make the iris rigid, and prevent extensive prolapsus. On the contrary, where the seat of threatened perforation is central, the pupil should be kept fully dilated, as the best safeguard against prolapsus. In case the ulcerative process is attended by great pain, with or without hypopium, a careful paracentesis of the cornea should be tried, in preference through the thinned bottom of the ulcer, and the aqueous humor carefully, but completely, evacuated. For fancied, theoretical reasons, some would advise eserine exclusively, in all cases of ulceration and infiltration of the cornea; but it is objectionable, because it greatly increases the danger of iritis and its consequences, always present in such emergencies. If there is increased intra-ocular tension, hypopium, and great suffering, nothing is so prompt and sure as the free use of atropine and paracentesis. If the edges of the ulcer are infiltrated and undermined, showing rapid lateral spreading, these same expedients may be followed by cauterization of the sloughing edges with carbolic acid. A small probe or hardwood toothpick, dipped in the acid, should be rapidly swept around under the necrotic tissues, rendering them white, acting as a prompt antiseptic, and arresting the destructive process. For many years I have been using the acid in this way, with increasing satisfaction. If anything can save an eye from total destruction in hypopium or infectious keratitis, it is the use of this remedy, repeated once or twice a day, following Saemisch's free corneal incision, which is made, in such cases, with a Graefe's cataract knife. The patient being under ether, and the eye fixed, the knife is passed through the cornea, near one edge of the ulcer, carefully pushing the point behind the ulcerated spot and making the counter-puncture, the edge presenting forwards, on the other side. Then by pushing the knife slowly and gently forward, the width of the ulcerated portion is split. The aqueous escapes with the shreds of lymph from the chamber, and complete relief of tension follows. If tough shreds hang in the incision, they may be drawn out with small iris forceps. Once a day afterwards, the lips of the cut are opened carefully with a probe or the probe-end of a Weber's stricture knife, and any gathering aqueous is allowed to escape. The eye should then be bandaged with carbolized or borated cotton, and opened once or twice a day for inspection, for the carbolic application if needed, and for the tapping of the chamber. Carbolic acid used in the same way, before or after simple paracentesis, repeated cleansing, continued use of cold water, atropine and boracic acid solutions, with free incision of the outer commissure to relieve pressure upon the ball, combined with the proper treatment of the purulent conjunctivitis, are the best means of saving the cornea in that dreadful disease.

In the management of phlyctenular keratitis, attacking as it always does delicate, scrofulous children, great importance attaches to the hygienic conditions of the patient. The child must have good nutritious food at regular intervals, and no cramming with trash between meals. Its body must be bathed once a day with tepid water, and the skin thoroughly rubbed. It must be dragged from its burrow in the dark, and carried forcibly out in the fresh air, for an hour or two twice a day. It must not be allowed to bury its face and heat up its eyes, and the room is to be only moderately darkened and is to be kept well ventilated. It will add greatly to the child's comfort and relieve its photophobia, to bathe its face thoroughly several times a day with very cold water. Immersing the face in a basin of iced water several times in succession, has a wonderful influence in controlling the spasm of the lids and enabling the child to open its eyes in the light. Any eczematous patches of the lids and nose, and fissures at the outer commissure of the lids, must be cleansed with soap and water, dried thoroughly, and freely brushed with a twenty-grain solution of nitrate of silver once a day till cured. Inwardly, quinia, two grains three times a day, for a child five years old, has a marked effect in controlling the photophobia. It may be kept up several weeks, if necessary, and followed by a long course of small doses of iron, the syrup of the iodide being one of the best preparations. Locally, atropine may be freely used from the start, and kept up for several weeks, or till the child opens its eyes freely in the light. Combined with it, or separately, a solution of boracic acid is beneficial. No astringents of any kind must be used in the acute stages. In a child from five to ten years old, a solution of two grains of sulphate atropia in an ounce of water, must be freely dropped into the eye three or four times a day, taking great pains to forcibly open the lids and get it in thoroughly. Care must be taken in the struggle to do this, not to drop or let the wash run into the mouth. The best way is to lay the child backwards, across the nurse's lap, and to take its head between the surgeon's knees, face upwards. Then pull the lids well open, and apply the wash freely.

When the photophobia is relieved, a weaker solution may be used, and less often, till it is finally omitted. The greater the intolerance of light, the more urgent the use of atropia, and the less danger of any poisonous effects. Where the phlyctenular process persists, and perhaps keeps pushing forward in the form of a band, more towards the centre of the cornea, in spite of this treatment, I again resort to the local use of carbolic acid. The offending patch or band in the cornea, is usually seen covered with a dirty-grayish, necrotic tissue. Holding the child's head firmly between the knees, as before, and separating the lids well, even using an elevator so as to expose the cornea fully, the spud may be used to freely scrape off this sloughing epithelial tissue, and even to bore out the phlyctenula. Then with the same spud, or a small probe, the acid is applied, limiting this carefully to the necrotic portion, turning it whitish, and then washing it with a few drops of cold water. This is done once a day, continuing the local use of the atropine. It is wonderful how quickly the extreme symptoms in such cases, may be thus overcome. The necrotic tissue, with too little life to live and too much to die, in the troublesome keratitis following smallpox, may be treated in the same way, with warm fomentations in addition, atropine, and tonics, with good diet. In phlyctenular keratitis, after the intolerance of light is overcome and all the acute symptoms have abated, the atropine should be omitted, and gentle, local stimulation employed. By general consent, the local use of pure, finely powdered calomel, dusted on the cornea once a day, is the best means of clearing off the remaining opacities. If the child is not timid, the powder may be driven suddenly on to the cornea by tapping the brush. In case it is refractory, its head may be held between the knees, as in using the eye-water. If this treatment acts well, it should be continued for weeks and months, till all corneal traces have cleared away. Weak astringents, excepting the acetate of lead, may be used for the same purpose, dropped into the eye once a day. Of course the iron and other tonics, cod-liver oil, malt, etc., with good diet, should be continued for months after the child is seemingly well. Otherwise the disease will recur. For convenient local use, the calomel may be applied in the form of a salve with vaseline, one grain to each drachm.

Syphilitic parenchymatous keratitis must be treated constitutionally as well as locally. The dwarfed figure, old and leathery face, characteristic teeth, perhaps nodes on the shins, and rheumatism of the knee-joints, can hardly be mistaken. And yet the worst forms of scrofula are so allied to syphilis that their differential diagnosis is by no means easy. It seems indeed that the two diatheses are often combined, and when syphilis and scrofula are married the offspring cannot be happy! A patient resort to tonics, good food, and careful hygiene, is necessary in all such cases. If the symptoms are such as to make it certain, or even probable, that tertiary syphilis is the fundamental malady, the careful use of mercurial inunctions and free administration of iodide of potassium must be added, and long and carefully persisted in, if a cure is expected. As iritis is often associated with this disease of the cornea, the free use of atropia, three or four times a day, is indispensable. Local stimulants in any form only aggravate the disease and intensify the danger. Warm fomentations, or poultices often renewed, and kept up for six or eight hours a day, are of great value. It is often a source of surprise, to see how well such cases generally recover sight, even under the most hopeless appearances. But the treatment will be long in every case, with occasional relapses. Rarely, undue hardness of the globe, pain, increased failure of vision, and other evidences of secondary glaucoma, will show themselves. In that case, notwithstanding the presence of iritis, the atropia must be omitted. Warm applications, long continued, and eserine two or three times a day, must now be the main reliance.

Should the excessive intra-ocular tension not yield in a few days to the eserine, an iridectomy must be tried. In the case of a girl fourteen years old, with this form of keratitis in both eyes, glaucomatous hardness was detected in one eye, and iridectomy proposed for the next day. In the mean time, a solution of two grains of eserine in an ounce of water was instilled every six hours. When the time came, the hardness was reduced and no operation was necessary. In some very malignant cases of this affection, the corneal infiltration leads to a sort of sclerosis and tendinous opacity of the entire cornea. In an instance of this sort, recently, in a little girl of eight years, with increased tension and pupillary membranes in both eyes, I practised a double iridectomy, as a last resort. Some months after, the eyes began to improve slowly, and the girl now has useful and improving vision.

Following ulcerative destruction of the cornea, two changes may occur: one, *flattening*, with more or less diminution of the globe in size; the other *protrusion* with enlargement, called *staphyloma*. If most of the cornea has been destroyed, with sudden perforation, and loss of the lens and part of the vitreous, the former is likely to be the result. Where the lens is not extruded, the cicatricial tissue, composed of the blended remains of the cornea and iris, is likely to yield slowly to the pressure from within, and show an unsightly prominence. The deformity and inconvenience of a corneal staphyloma vary much in different cases. If neither be very great, the patient may be let alone, and watched. If the deformity be unsightly, and especially if the protrusion be constantly inflamed and painful, surgical interference is demanded. Should the whole globe be enlarged and seriously altered, the eye being a constant source of pain and danger, enucleation will be safest. But if the changes are confined to the corneal region, the back portion of the globe being natural in appearance and size, the staphylomatous portion may be removed. Thus the eye will be reduced in size, and the patient enabled to wear an artificial eye. I prefer a reduced stump like this, to the small movable button only, that remains after enucleation. But in either case, an eye can be worn with comfort and great benefit to the personal appearance. The easiest and best operation in such a case, is simple ablation. The patient lies on his back, and does not often require ether. The lids are separated by the fingers of an assistant, or by the stop-speculum, the eye is fixed by stout forceps, and the desired portion removed by a Beer's cataract knife. The tumor being transfixed from temple towards nose, with the edge of the knife held upward, rapid movements are made to finish a regular flap above. Then, seizing this flap quickly with toothed forceps, the knife is turned, and the removal finished below. Of course the lens escapes, and a gush of vitreous follows, before the knife is reversed. But the section must be completed quickly, the lids instantly closed, and a cold compress applied by a rather firm bandage. Otherwise hemorrhage may take place from the bottom of the eye, pushing out the remains of the vitreous, and may be followed by suppurative elimination and extreme atrophy of the stump. Several ingenious methods have been practised, in which the conjunctiva is stitched to close up the opened cavity. But this causes delay, and does not leave as regular a stump for the glass eye as a well executed, simple ablation. The closed lids, with pressure kept up for a few days, secures a good result. In old persons, with appearances that indicate danger of hemorrhage, enucleation is safer, and the result more prompt. (Plate XXVII., Fig. 5, represents a well-marked case of the form of staphyloma known as *buphthalmus*.)

A word as to *prothesis*. The patient nearly always wants a larger eye than he ought to wear. After enucleation of a much and long enlarged eye, there is an immense cavity, and the wearer thinks that this ought to be filled out even with the other eye. It cannot be, without glassy staring, and immobility and discomfort. The artificial eye should always be smaller than the other, allowing easy closure of the lids over it. It is seldom that the same eye can be worn more than twelve or eighteen months with comfort and safety. If corroded on its surface or edges, irritation, slow adhesions of the lids to the stump, and contraction of the space will follow, till no eye at all can be borne. An atrophied eye, with the clear cornea preserved, will very seldom tolerate an artificial substitute, and wearing it may give rise to sympathetic ophthalmia. Dense leucoma of the cornea, in an eye of natural size and free from irritation or increased tension, may be greatly improved in appearance by *tattooing*. This is done with pure India ink, and generally requires to be repeated two or three times, to secure sufficient staining. The patient lies on his back, with his eyelids well propped open, and the fluid, brushed on the part to be stained, is pricked in very thoroughly with the tattooing needles. The ink is applied repeatedly, and the needles used, till the coloring is satisfactory. When done, the cornea is left exposed for some minutes till it dries.

Little irritation follows, and the cosmetic process may be repeated, at intervals, till the end is gained. If not a source of pain and danger to the other eye, and presentable in looks—or if it can be made so—I much prefer to preserve the natural eye. Artificial eyes are an endless source of trouble and expense, and few persons are so prudent as to be able to wear them at all, for many years.

Diseases of the Iris.

Malformations of the Iris.—Among malformations of this part may be especially mentioned the affection known as *coloboma iridis*, or congenital fissure of the iris, and that known as *multiple pupil*, of which a remakable example, involving both eyes, is illustrated in Plate XXVII., Figs. 3 and 4.

Iritis.—Remembering the delicacy and wonderful activity of the iris, we are not surprised to find it the seat of frequent inflammation. Iritis may run an acute course, or may appear in a slow and insidious form.

Symptoms.—These, in most cases, are so sharp-cut and characteristic, that a false diagnosis is inexcusable. And yet how often is this disease pronounced "sore eyes," and treated with nitrate of silver, till hopeless closure of the pupil takes place! While iritis yields to timely and intelligent treatment, with great certainty, nothing can be more fatal than such a mistake of diagnosis. Severe and somewhat paroxysmal pains in the eye and face, too, are attributed to simple neuralgia, with serious delay in the recognition of the true malady. Hence the vital importance of a speedy and correct diagnosis. The *objective* symptoms are discoloration, loss of the natural brilliancy of the iris, as well as of its fibrous appearance, sluggishness of the pupil, and finally adhesions to the capsule of the lens, synechia posterior. The changed color, depending much upon the original color of the iris, is explained by the increased amount of blood in its texture, and the extravasated elements. When but one eye is affected, the color contrast and difference in the activity of the pupils will be striking. Sometimes the occurrence of inflammatory nodules, near the pupillary margin or elsewhere, will attract attention. There is no one symptom, or group of symptoms, that is so pathognomonic of syphilitic iritis as these gummy formations. Hypopium is not very infrequent, but is oftener detected in ulcerations of the cornea, particularly when deep and threatening perforation. A pinkish zone of injection around the cornea, fading in intensity towards the equator of the eye, is another constant symptom of acute iritis. Now and then inflammatory chemosis, and extravasations of blood over the sclerotic conjunctiva, are seen, and indicate an intense form with probable panophthalmitis. There is always some impairment of vision, and often a very serious one, capable of being demonstrated objectively by the type tests. Blurring of sight is due to cloudiness of the aqueous humor, deposits in the pupil, and sometimes to turbidness of the vitreous, due to complicating choroiditis. Indeed, it often happens, that optic neuritis or neuro-retinitis, develops with an iritis, but is overlooked.

Subjectively, the patient complains of intense pain in and around the eye, usually aggravated at night, or by lying down. These severe, circumorbital pains are characteristic. Sometimes the pain is confined to the eye; at other times it is exclusively in the bones around; but usually it is in both. Photophobia and weeping are not strongly marked in this disease, as they are in keratitis. The sluggishness of the pupil, in response to varying degrees of light, may range from complete immobility to but slightly diminished motion. This may be due to spasmodic contraction of the irritated sphincter, or to plastic exudation, or to both. It is not easy to tell, by simple inspection, whether adhesions of the iris to the lens capsule are present, and to what extent. Hence the value of atropine, in the diagnosis. If no synechia exists, the pupil will dilate circularly, and eventually largely. But if bound down, the points of adhesion will remain fixed, while the free portions dilate. This gives the pupil a strikingly irregular form, and makes their presence positive. By the use of atropine and oblique illumination, the adhesions can be seen with great satisfaction.

Iritis is practically divided into plastic, suppurative, and serous. These forms sometimes exist together. The *plastic* is distinguished by a free effusion of lymph, with prompt and firm adhesions to the capsule, and false membrane in the pupil; the *suppurative* by hypopium; the *serous* by less marked ciliary injection, less pain usually, and a more insidious course. Likewise, with turbidness of the aqueous, and dimmed vision, there are seen groups of minute, dirty points of precipitates on the membrane of Descemet. These are best seen by oblique illumination, and through a magnifying lens. In serous iritis, there is often an associated disease of the ciliary body and choroid, with increased tension of the globe. This glaucomatous hardness is a very serious complication, and the surgeon should never fail to search for it every day. Its possible development should make us cautious in the use of atropine, which increases the tension. Its actual presence forbids atropine altogether, and calls for eserine, which diminishes intra-ocular pressure. When this complication arises in serous iritis, the pupil becomes dilated and sluggish, but even then slight adhesions with the capsule may form. There are likely to be inflammatory deposits in the extreme rim of the anterior chamber, and peripheral adhesions between the iris and cornea, with obliteration of Fontana's spaces. This is said to arrest the filtration of fluids from the eye, and to give rise to increased tension.

In sympathetic ophthalmia, serous iritis is much less dangerous and more controllable than the plastic variety, which nearly always leads to blindness. The so-called condylomatous variety (gummatous) is nearly always syphilitic. There may be but one nodule, or many. If numerous and large, they rest against the cornea, and completely fill the anterior chamber, as I have seen in a few cases. They are always permanently glued to the lens, and the iris-tissue afterwards undergoes atrophy to a high degree. Sometimes hypopium is associated with them, and may rarely be the result of an abscess of the iris bursting into the aqueous chamber.

In the *etiology* of iritis, syphilis is by far the most prolific cause. After this come the rheumatic diathesis and scrofula. Of course an injury may occur and produce its effect in any constitution. Iritis from injury is apt to be mild, except when irritated by a traumatic cataract, or by a foreign body in the eye. As a syphilitic disease, iritis usually is one of the so-called secondary manifestations. It may be present with ulcerated throat, eruptions on the skin, and falling away of the hair; but not infrequently it precedes all of these lesions, while in other cases it follows them at some distance. The presence of iritis in any given case does not prove the existence of syphilis, but should always awaken thoughtful inquiry.

The diagnosis settled, and the etiology cleared up as well as possible, we inquire, what is the *prognosis* of iritis when left to itself? Its tendency is to recovery, but with permanent adhesions and some impairment of sight; besides, any remaining synechia increases the tendency to repeated relapses, and to final destruction of vision, giving rise at a later period to choroiditis and to glaucoma.

Treatment of Iritis.—This divides itself into local and constitutional. The main indication, of course, is to cut the disease short, if possible, and save the eye from permanent lesions and their consequences, immediate and remote. The chief object in the use of *local remedies* is to relieve suffering and dilate the pupil fully, so as to prevent adhesions and false membranes. The mydriatics must be used promptly and heroically, from beginning to end of the treatment. If the pupil can be dilated, and kept so, thus preventing adhesions—or, in case they have already formed, if they can be detached and kept from reforming—a great point is gained for the integrity of the eye. The cheapest and best substance of this class is the sulphate of atropia. It may be used for adults in a four-grain solution, dropped freely into the eye every three or four hours, or every hour at the start, till the pupil is freely dilated. The only danger from its free use is constitutional disturbance. If prevented from entering the puncta and running down the throat, there is little risk. This is done by drawing the lower lid a little from the eye, and holding it a few minutes after each application. A cloth over the end of the finger is then pressed into the corner to remove what remains of the atropia solution. The frequency of application should depend on the pain and the resistance of the pupil. As soon as the latter yields largely, the use of the atropia may be less frequent, but enough to keep up full dilatation.

The pain is much relieved, and the relaxing influence of the atropine hastened, by leeching. Four leeches may be applied to the temple, or side of the nose, at once. Then, as fast as one is filled and falls away, another may be applied, till six, eight, or ten have bitten. The bleeding is encouraged by warm fomentations. The leech should never be allowed to bite on the loose skin of the lids. Of course the eyeball must be guarded with great care. I prefer the natural leech to the artificial, or to the ordinary wet cupping. Still, Heurteloup's artificial leech, applied to the temple, does well.[1] Local depletion is not generally necessary, but expedites the cure, when used. Cold water applications are not beneficial. Warm fomentations, or the persistent use of warm poultices, in the obstinate cases, particularly if there is a glaucomatous tendency, are often of great benefit. Of course, purgatives in the beginning, and at times afterwards, with free anodynes at night to allay pain and promote sleep, are valuable antiphlogistics. In cases of patients harassed by great pain, with resistance of the pupil to the action of leeches and atropine, I have often given immediate relief by a paracentesis. If preferred, a subcutaneous injection of morphia may serve the same purpose, but it has not as much control over the progress of the disease. I often anticipate the use of leeches by the paracentesis. In the serous variety, atropine must be used less freely, and with more watchfulness, omitting it at once, and resorting to eserine, if increased tension is discovered. In such emergencies, the protracted use of warm poultices, often renewed, does great good. If the glaucoma resists all these, a paracentesis should be tried, and then, if need be, an iridectomy. Do not let this fatal condition run on very long. If the atropine disagrees or proves insufficient, a four-grain solution of duboisia is still more powerful, but more care is needed to watch against its general effects.

Constitutional treatment is directed especially to the diathesis found to exist. In the rheumatic, salicylate of sodium, the subcutaneous use of pilocarpine, and other numerous and vaunted remedies for rheumatism may be tried. Great attention to the stomach, kidneys, and cutaneous function, with careful avoidance of exposure to cold, is required. If the syphilitic virus is present, mercury, by inunctions, inwardly, or by baths, is indispensable. Following this, or from the start, if the patient is deteriorated in blood and strength, the iodide of potassium is an invaluable remedy. Some form of general treatment should be kept up for months, to prevent relapses, and the atropine ought to be continued, once or twice a day, for several weeks after all local symptoms of inflammation have ceased.

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[1] See Vol. I. page 507, Fig. 81.

If extensive synechia results, and relapses follow, an iridectomy will, probably, rescue the eye. Should the pupil be closed by a dense false membrane, and all communication between the chambers cut off, this is to be done at once. Still greater urgency is demanded if the periphery of the iris has begun to bulge forwards, the pupillary area being drawn back. In syphilitic iritis, the constitutional symptoms, and the local inflammation, should be well controlled before doing an iridectomy, as otherwise plastic formations will again close the pupil. In chronic forms of iritis, with acute relapses, an iridectomy is often a valuable antiphlogistic, and the only means of arresting the disease. But there is room for great discretion in deciding that such an emergency exists as requires iridectomy, and great skill is needed for the execution of so important an operation. People are always ready to attribute the most absurd and remote consequences to the direct action of a surgical operation, if any has ever been performed. Little need be added on the method of this operation, to what will be found under cataract and glaucoma. I much prefer the Graefe to the spear knife, especially with a shallow anterior chamber. When the iris is free from all adhesions, and its tissue not rotten and friable from disease, the operation, after the incision, is very easy. When adhesions are confined to the pupil, the rest of the iris being free, no difficulty is usually experienced in seizing and drawing it out. But the entire agglutination of the posterior surface of the iris to the lens capsule, makes a satisfactory iridectomy almost impossible. In such extreme cases the lens will need to be extracted, and afterwards the tough membrane, composed of iris, inflammatory deposits, and lens capsule, should be freely incised with Wecker's *pince-ciseaux*.[1] Hopeless as seem some of these cases, they should not be given up till such thorough operations have been faithfully tried. Success sometimes crowns a desperate effort.

Tumors of the Iris.—Tumors, benignant as well as malignant, sometimes develop in the iris. The former, when not too large, may be removed with the portion of iris in which they grow. The latter, of course, demand an enucleation of the eye, as the only hope for life. Among the former are rare dermoid growths, that take their origin from rudiments of skin, driven in and lodged on the iris by injuries. A more frequent development in the iris, always following an injury, is a cyst. Plate XXVII., Fig. 2, represents such a growth. The eye had been injured by a small shot, which lodged in the iris. After long years, the cyst developed and grew to a degree that destroyed the sight, and caused great suffering. I enucleated the eye, and in making sections for microscopic examinations, the shot was cut through. The entire extent of the cyst wall is seen in the illustration. In another case, in a boy of nine years, the cornea had been injured by the sharp corner of a piece of slate. A cyst afterwards grew from the iris, and attained a large size. I removed it with the iris from which it grew, but in a few months another cyst showed itself. This was also extracted in the same way, with permanent relief, and preservation of some sight. In a third case, I extracted a cyst that I had mistaken for a lens in its capsule, luxated into the anterior chamber. I made quite a free incision in the cornea, and, finding my mistake, removed the cyst and iris as usually advised. The patient recovered promptly. Since then the cyst has been partially reproduced, but seems to have been obliterated by an attack of inflammation, and now appears cured, with some vision. Had I made a critical examination of this patient's eye, the mistake could have been avoided; but the operation would have been essentially the same, and with the same result. The eye was inflamed and painful, and the history and strong resemblance to a luxated lens led me to operate at once.

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[1] See Fig. 873.

CATARACT.

The most striking physical property of the refracting media of the eye, is their great clearness. Without this, neither the cornea, the crystalline lens, nor the vitreous could act as image-producing structures. The absence of bloodvessels in them, and the transparency of their elementary textures, secure their perfect functional action. And yet they are vital, animal membranes, moulded and arranged as a system of lenses. Nutritive changes are constantly going on in them, as in other parts of the body, but their nutrition is precarious in proportion to the distance of their source of supplies, and the difficulties of transportation. The wonder is that their lesions are so rare. The lenticular system is composed of the lens proper, the inclosing capsule, and the suspensory ligament by which it is held in place. The transparent capsule closely embraces the lens, and is united with it by means of a layer of intracapsular cells, through which the nutritive changes are effected by a system of endosmosis and exosmosis. Of course, the influx and efflux of the nutritive fluids must be through the capsule. The supplies are second-hand, from the vitreous and the aqueous humors. Hence morbid changes in the chemical composition of either or both these humors may affect the nutrition of the lens, and produce cataract. Their supplies also come from without, the aqueous probably being secreted by the bloodvessels of the ciliary processes, and the vitreous mainly from the choroidal circulation. Hence disturbances in the free circuit of fluids through the capillaries of these tissues may indirectly affect the lens and cause cataract. Then again, as all the tissues are fed from the blood, an abnormal change in the healthy constituents of this pabulum may lead to disease in any organ, especially in the transparent and bloodless structures, like the lens. Finally, the daily dying of the living body, that begins *in utero* and ends in death, results from the increasing stagnation of the vital currents, with the progress of years.

In the crystalline lens, the gradual changes of consistency, from hardening and drying of its textures, are indicated by the progressive failure of the accommodation with increasing years. This prepares the way for senile cataract. In childhood, the lens is soft and elastic, yielding in form to the delicate action of the ciliary muscle in focusing for very near objects; but this elasticity is slowly lost, till, at sixty or sixty-five years of age, no power of accommodation is left. Presbyopia then is due to physical changes in the lens, and comes to all as age advances. But its inconveniences differ according to the refraction of the eye.

Suppose the subject is *myopic* in a rather high degree, say one-eighth, which means that his farthest point of distinct vision is eight inches from the eye. In boyhood, by voluntary action of the ciliary muscle, he can read, and prefers to read, at three or four inches, his nearest point of easy accommodation. As he grows older and the lens hardens, he prefers to read a little farther away. The near point thus gradually recedes towards his far point, which it reaches when he is fifty or sixty years of age. Then he reads at his far point (which is not *far*), eight inches, and reads well without the aid of glasses. His range or power of accommodation is gone, and his myopia remaining the same, all these years, with the same imperfect sight for distance, the failure of focusing for near objects is not felt. The patient even imagines that his near-sightedness has improved with years, because he reads with the book farther away now than when young. Actually it has not, and he now needs a negative lens No. 8, for perfect distant sight, as always before.

Suppose the refraction of the eye is *emmetropic.* Then the patient has a range of accommodation, say from three inches to an infinite distance, when young. As years flow on, his near point goes away towards the far point, and at forty or forty-five has reached ten inches, when he begins to feel the need of glasses to read. When all focusing power is gone, the near point has gone out to an infinite distance, the far point of an emmetropic eye. Such a patient must have magnifying glasses to read, but sees perfectly in the distance without any aids.

Again, let us suppose that the refraction is *hyperopic.* In emmetropes the ciliary muscle is at complete rest in all but close work. In hyperopes it is always on a strain, except when the eyes are shut, as in sleep. Now with years, the same hardening process goes on in the lens, and the near point recedes. Such persons often need convex glasses to read with, even when young, because the strain on the accommodation is excessive and fatiguing. Presbyopia tells on them much earlier than on emmetropes, and when all accommodation is gone at from forty-five to sixty years of age, the sight fails for distant as well as for close objects, and they see badly far off without glasses, and still worse near at hand. Such an unfortunate now needs two pairs of magnifiers, a weaker for distance, and a stronger for reading. These are the three ordinary conditions of refraction, two of them anomalous, and one perfect. Only one other anomaly exists, and that is astigmatism in its two forms, hyperopic and myopic. Correctible astigmatism is due mainly to irregularities of curvature in the cornea, and hence may be left out in this hasty summary of inconveniences from hardening of the lens. These practical observations seem necessary to a clear understanding of the pathology of cataract.

While cataract is seen at all ages, and may even be congenital, it is much most frequent in advanced life. The natural, nutritive change that takes place in the lens of an elderly person, supplies a good soil for senile cataract. In old people the nucleus of the lens is large, hard, dry, and of an amber color, even when clear. Its wear and repair have in a good measure ceased, and the nutritive activity of even the cortical lens substance is very sluggish. Hence, any of the causes that bear heavily on nutrition, may determine senile cataract. While any one, without regard to parentage, may become a victim of cataract, still there is a strong hereditary predisposition to it in certain families, which shows itself in the young as well as in the old. The members are attacked, usually, at about the same age. The *etiology* of cataract is often inscrutable. The hardening and drying nucleus of old people is supposed to drive out its quantum of water into the softer cortical, producing swelling of its lens fibres and their disorganization. The lens is then supposed to give off its soluble albumen freely to the aqueous humor, and to absorb from it excess of water. This leads to the swelling of the lens cortex, in the progress of cataract, and to reduction in depth of the anterior chamber. When the substance of the lens is opaque quite up to the capsule—when the cataract is said to be mature—a partial absorption of the softened cortical takes place, and the chamber deepens. If this process has gone on for years, the capsule comes to embrace a hard, dry nucleus, and adheres to it as if it were waxed. We call it then a hypermature cataract. Simultaneously with beginning senile cataract, patients often become myopic. Those that were myopic before the changes in the lens, become more so. This is doubtless due to the swelling of the lens during the cataractous alterations. Old people who find themselves laying aside their reading glasses for weaker, or even reading without any, have become myopic. In proportion as they acquire "second sight" for reading, they see worse in the distance. Concave glasses then help them to see remote objects better, as they do with any myope. In many or most of these cases, there will be found incipient cataract, and, not infrequently, floating corpuscles in the vitreous, showing disturbed nutrition from choroidal irritation.

CONGENITAL CATARACT.—So-called cases of congenital cataract doubtless often begin very soon after birth, and before the infant shows any indication of how it sees. Congenital, or early infantile cataract, may be partial or complete. The partial embraces two varieties, the polar and the lamellar. The *polar* is nearly always at the anterior pole of the lens. There is seen a small, round, whitish opacity, in or near the centre of, and just within, the anterior capsule. When the anterior polar cataract is large and prominent, projecting beyond the plane of the pupil into the anterior chamber, it is called pyramidal. It was once thought that these opacities were deposits on the outer surface of the capsule. But the whole mass is within the capsule, which is pushed forwards. The pathology of these cases is simple: they can generally be traced to the same cause, that is, perforation of the cornea, though in very rare instances they cannot be explained in this way. In ophthalmia neonatorum, central and limited ulceration and perforation of one or both corneæ, take place. The aqueous escaping, the anterior capsule comes against the cornea, and is agglutinated to it. When the aqueous is again retained, and the chamber re-established, the two surfaces are separated and the adhesion severed. By some means this temporary union causes proliferation of the intracapsular cells, and a limited and stationary opacity. Most frequently a small corneal opacity may be detected, indicating the seat of the perforation, and oblique illumination will nearly always reveal it. Of course, the history of purulent conjunctivitis will help to clear up the diagnosis.

Lamellar cataract (*Schichtstaar*, of Jaeger) begins in very early life, and presents such marked characteristics that it can hardly be mistaken. It corresponds to the axis of the lens, and hence centres with the pupil. The sharply defined, circular opacity of the lens may be less or larger than the average size of the pupil. It has a dull-grayish look, and by a careless examination might be supposed to involve the entire lens. Dilatation of the pupil, and oblique illumination, will show at once what it is. While the opacity is nearly or quite circular, and sharply defined, the edge is apt to be a little ragged or serrated. The opaque spot is back of the capsule, between it and the nucleus. The laminæ next the capsule, the nucleus, and the entire periphery of the lens, are all clear. Rarely there is seen a corresponding opacity behind the nucleus, and of course deeper seated in the lens. Opthalmoscopically, the dilated pupil is uniformly red, except the central opacity, which has a reddish-brown appearance, the centre letting more light through and looking redder. In the school period, such patients are often near-sighted, perhaps from the constant habit of holding the book close and straining the accommodation. Lamellar cataract, after reaching a certain point, becomes stationary, and generally remains so during life. Rarely its progress is renewed, leading to total cataract. The patient is usually brought for advice on account of supposed near-sightedness, because he holds small objects unduly close, to see them. He brings the book near his eyes because he does not see well, and not because he is myopic. Still, he often becomes so, as proved by the usual tests.

Either beginning *in utero*, or very soon after birth, a soft, milky-white, total cataract is sometimes seen, which usually involves both eyes. It has a tendency to become liquid, in later years, and may undergo partial or complete absorption, leaving only a dense, opaque capsular membrane. If neglected until the child is ten or more years old, and then removed, good sight is seldom restored, although the vivid response of the pupil, and the quick perception of light, may have led the operator to expect and promise a good result. The retina never having exercised its functions, rapidly loses its capacity for perfect sight.

In youthful subjects, another form of cataract is occasionally seen, partial in the beginning, but progressing rapidly and leading to blindness of one or both eyes. Sometimes it starts in the nucleus and extends to the cortex. In other cases it is just the reverse, and the cataract has a peculiar, radiating, star-like appearance in the anterior cortical. In such persons the lens is more solid, and has sometimes a quite firm nucleus, especially if not operated on for many years.

Senile Cataract.—This is by far the most frequent variety, and the name indicates that it has for its victims people of riper years. The sclerosed nucleus in old persons is amber-colored, very firm, and dry, and it undergoes little change in senile cataract. The alteration is chiefly in the cortical portion, and begins usually at the periphery, in the form of little striæ, sometimes called *arcus senilis lentis.* Not affecting the sight in this incipient form, the striæ are not perceived by the patient, nor seen by the examiner, except rarely. At a later period they send out, towards the pole of the lens, little prolongations, like feathery frost crystals. These, reaching the area of the pupil, begin to disturb vision. In examining a great many people, I find that the marginal opacities usually begin at the lower and inner edge of the lens, and thence extend to the rest of its circumference. Little by little these marginal striæ multiply and extend towards the centre of the pupil, producing slowly increasing dimness of vision. As they widen, become confluent, and involve the whole cortical, which in the mean time becomes perceptibly swollen, the amber nucleus is more obscured, and the cataract is at last mature. We say that maturity is attained when the opacity involves the entire cortical, up to the capsule, so that the iris throws no visible shadow. In this stage, the opaque, soft cortical undergoes slow absorption; the anterior chamber deepens, and the amber nucleus again shows itself more plainly. Left so for a long time, the cataract becomes hypermature.

The progress of cataract in different patients is variable, but nearly always slow, requiring often many years to reach completion. Senile cataract attacks both eyes, but usually not at the same time. One is apt to progress faster, and get blind before the other. Cataract is never attended by pain or any inflammatory symptom whatever. If pain accompanies its development, glaucoma or some other grave complication is its explanation. The only discomfort, aside from the trouble in seeing, is manifested by shrinking from light, and efforts to turn the back towards it. Thus the eyes are shaded, the pupils dilate, there is less diffusion of light, and the patient sees better. He often finds relief in a broad-brimmed hat well down over the eyes. When the nucleus is more opaque than the margin, the patient sees better on cloudy days, before sunrise, or after sunset. If the reverse obtains, he sees better in the bright light. The pupil will be found active in response to light, the iris natural, and the tension of the globe normal; in short, no evidences of disease are present, except the cataract. In old people the pupil is smaller and less active than in early years, but it varies in different persons. While the ready response of the pupil to light is a good indication of the state of the retina, it is not infallible. In some cases of retinal detachment, its movements are energetic and misleading, while in other persons with a sound fundus, the pupil does not respond at all. There may be motor paralysis of the fibres of the third, or of the sympathetic. The degree of dilatability under atropine varies, but it is always less than in youth. Large dilatation with mydriatics, in old people, is favorable.

Traumatic Cataract.—This class embraces all cataracts that directly follow injuries of the eye. There is nearly always a wound or rent in the capsule, by which the lens substance is exposed to the action of the aqueous. The dangers of traumatic cataract are much less in young people than in old. In the former, the absorbents are more active, and the lens is soft and ready to dissolve. The hard, dry lens of the aged, is not capable of absorption. In all cases, the course of the cataract will be influenced by the complications. If the cornea and iris have both been wounded, or if the injury be through the ciliary region especially, there will be great danger of loss of the eye. The additional lodgment of a foreign body in the eye, enhances the risks very greatly, unless the foreign body be lodged in the lens and can be extracted with it, when the prospect is far better than under other circumstances. If the lens has been luxated, as it is more apt to be in old subjects, the prognosis is most unfavorable. A very protracted course is certain, except when immediate extraction is effected. There is great danger of loss of vitreous, in such cases, if an operation is attempted, but without an operation, glaucomatous disorganization is very sure to follow. Even a free iridectomy often does not prevent loss of the eye, with endless suffering, and enucleation may at last become necessary. Prolapsus of the iris in traumatic cataract is a common and troublesome complication. If no other serious injury be present, and the patient be young, the cataract may entirely disappear, in a few weeks or months, by absorption, with recovery of useful vision. Even then the rent in the capsule may close, and a tough secondary cataract remain to seriously obstruct sight. Altogether, the prognosis of traumatic cataract is very unfavorable.

Treatment of Cataract.—The question of diagnosis and ripeness of cataract being settled, we interrogate the retina with a view to treatment. Nothing but surgical interference can do any good. If the retina be sound, even in the most dense cataracts, there will be prompt perception of light and accurate projection. We test these points in a dark room, with the use of a candle, as follows: The room should be from fifteen to twenty feet long, and well darkened. A single, lighted candle is held at one end of the room, and the patient faces it from the other, the eye not tested being well closed. If he can tell quickly, when the candle is darkened by the hand, and suddenly uncovered, his central perception is good. But that is not enough. Enforcing stillness of the eye in one direction, the *covered* candle is carried to the left, right, above and below, in the field of vision. In each new position, the light is suddenly uncovered. If he sees and can point to it, without turning the eye, the field is intact and the projection good. Defects in the field, more or less complete and large, indicating detachment of the retina, choroidal patches, or other serious lesions, excite great doubts as to the probable success of an operation, or perhaps forbid it entirely. Slow and uncertain perception in the line of vision, is a very bad indication. The *distance* at which a candle can be discerned, is a good test of central acuity. If the light must be brought very close before it can be recognized, the prognosis is bad, and if not perceived at all, hopeless. The ophthalmoscope may be used for the same trial. By turning the lamp low, and then throwing the light on the pupil, from different directions, the ready perception and integrity of the field may also be established.

Not only must an intelligent diagnosis of the state of perception, and the integrity of the visual field, be made out; but other questions must be settled, before resorting to a surgical operation. Let us assume that cataract exists and is fully matured, and that the functional examination of the retina is satisfactory. But only one eye is involved. Monocular cataract, unless traumatic, is not common, and it is always wise to wait a year or more, to see if the other eye will remain unaffected. If it do, and if the subject be young, an operation may be advisable. In senile cataract, with one eye still intact, I would emphatically decide against any operation, till incipient lenticular changes had begun in the sound and seeing eye. After that, I should leave it to the choice of the patient, whether to wait till it too was nearly or quite blind, or not. It must be remembered that no operation for cataract is free from serious risks. A patient advanced in years, with one good eye, had better endure the inconvenience of one-sided blindness, to which he soon becomes accustomed, than incur the dangers of an extraction. Should all go well, and the best possible result be secured, the sight is so much inferior to that of the other eye, that the patient does not usually appreciate the gain. Should an unforeseen accident occur during the operation, or should disastrous reaction follow it, the eye will probably be lost, with sympathetic danger to the other. In a young person, with a prospect of long life, and where a less risky procedure may be resorted to, one may cautiously advise it for the sake of looks, and to relieve the patient from the inconvenience of a blind side.

Another question is, whether if both eyes are blind and ready for operation, it is wise to operate on both at the same sitting. In children it is proper. In adults, as a rule, it is safer to take one at a time, leaving a few days, or longer, between the operations. Still another point of conscience is this. Suppose one eye has been operated on with success, the patient being able to read well and conduct his business: Is it then advisable to operate upon the other? I would say no, unless at the urgent request of the patient, and after fully advising him of the possible disasters. I shall never forget the case of an old gentleman from one of whose eyes I extracted the lens with perfect success. One week after, at his instigation, I repeated the operation upon the other eye. All went well, at the time, and for a few days. Then iridocyclitis set in, from which he lost this eye, and was soon blinded in the other from sympathetic ophthalmia. The same thing may happen to an eye not yet operated on, and not even cataractous, from a painful failure in the first operation. Who, of large experience, has not met with this misfortune? Surgeons and physicians generally have very trivial notions of the delicacy and seriousness of cataract operations—an opinion which is confirmed by the publication of successful cases only, as personal advertisements, rather than in the interest of the healing art.

Operation by Solution, or the Needle Operation.—There are but two operations now practised for cataract: solution and extraction. The former is applicable only to soft and absorbable cataracts, as they are met with in children, and in persons under twenty years. The subject young and healthy, the entire lens involved, and the little patient reasonably tractable, this operation is attended by slight risks and promises well. The pupil is to be well dilated by atropine, and the patient put in a good light, on a lounge, bed, or operating table, and rendered thoroughly insensible with ether; the stop-speculum[1] is then introduced, and the eye fixed by the large, toothed, fixation forceps[2] held by the left hand. The right holds the small stop-needle (Figs. 862, 863), passes it carefully through the cornea, about half way between its centre and external margin, towards the lens capsule, carefully watching the point to see when it pierces the latter, and to avoid going deeply into the lens. Then by a quick elevation of the handle, the cornea acting as fulcrum, the capsule is divided transversely to a short distance. Then the needle, being slightly retracted, may be advanced so as to make a second incision in the capsule, at right angles to the first. In that way, the elastic capsule being incised crucially, the points retract and leave a small portion of the lens exposed to the contact of the aqueous. The lens imbibes the humor, swells, breaks down slowly, and at last is dissolved by the aqueous, leaving a clear pupil where the capsule was opened. Usually the rent closes, after a few weeks or months, and the solution ceases. Then the manœuvre must be repeated till the pupil is free from obstruction. The needling process may need to be repeated several times, and the restoration to sight can only be expected in the course of many weeks or even months.

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[1] See Fig. 860, page 199, *supra*.

[2] See Fig. 861, page 199, *supra*.

Fig. 862. Fig. 863.

Bowman's stop-needles, curved and straight.

It must be remembered that the intra-capsular cells always swell, multiply, and produce a thickening of the capsule around the rent, as the lens substance itself dissolves. A grayish-white opacity will be seen in the capsule, and, in case the rent closes, it will be found much tougher at the second and third punctures, than at the first. Indeed, it will often be found necessary to use two needles, in order to tear it sufficiently, introducing one inwards and the other outwards, passing them through the tough membrane at the same place, and then separating their points by suitable movements of the handles. If the first incision be too large, and the lens swell rapidly, pressing against the iris and giving rise to acute plastic iritis, with perhaps glaucomatous hardness of the eyeball, an incision must be made in the cornea with a spear-knife, and the softened lens must be extracted. It will readily come out with the aqueous, assisted by a spoon.

For a few days or even weeks after a needle operation, the patient must be kept quiet in a moderately darkened room, for fear of dangerous reaction. If pain, tenderness to light, weeping, and ciliary injection come on, cold applications, and the energetic use of atropine, are the best remedies. In all cases, the eye must be daily tested as to tension. If that becomes excessive, repeated paracentesis must be employed, and, if need be, a linear extraction of the soft and swollen lens. The pupil must be kept well dilated during the whole course of treatment, so as to withdraw the iris from contact with the swelling lens.

Traumatic cataract, in young subjects, may be treated in the manner above described, but if a foreign body be lodged in the eye, the danger of the operation is greatly increased. Should the foreign body be seen in the lens, they may both be extracted together by a linear, corneal incision. In lamellar and polar cataracts, the vision, if possible, should be improved by a small iridectomy, which is almost free from danger. If dilatation of the pupil improves the sight materially, a well-executed, small iridectomy will help still more. As these cases are partial and stationary, if reading vision can be secured, it is vastly safer and surer than a cataract operation, in which the danger of excessive swelling is very great. If the entire lens is liquid, a broad needle[1] may be used to puncture the capsule. Before being withdrawn it should be slightly rotated, and the fluid lens allowed to escape with the aqueous. A grooved needle (Fig. 864) may also be employed.

In older subjects, where the nucleus is a little firmer, but not hard, a

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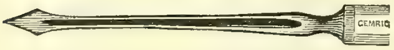
[1] See Fig. 859, page 199, *supra*.

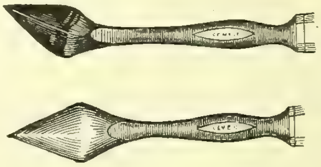
linear extraction is preferable. For this purpose the pupil must be widely dilated, the stop-speculum introduced, and the eye well fixed, the patient being under ether. A broad spear-knife, or keratome (Figs. 865, 866), is passed through the cornea, midway between centre and margin, so as to open the chamber by an incision five or six mm. in length. A cystotome (Fig. 867), passed very carefully through this incision, opens the capsule freely. Then while the outer lip is pressed gently back by a small curette (Fig. 868), another is lightly pressed on the opposite side of the cornea, and the lens made to come slowly out in fragments. If discission has previously been practised, or if a traumatic cataract demands this operation, the cystotome is usually not needed at all. Great care must be taken to avoid prolapsus of the iris during this operation. If it occurs, and is not readily reduced with the spud,[1] or by gentle closure of the lids and rubbing over the cornea with the finger, aided by eserine, it must be gently drawn out and snipped off close to the cornea. The future welfare of the eye demands that no iris shall be left in the corneal incision; and this provision applies to all forms of extraction.

Fig. 864.



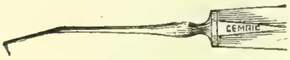
Grooved needle for fluid cataract.

Figs. 865, 866.



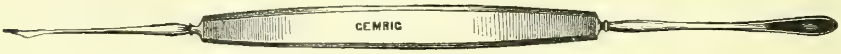
Jaeger's keratomes.

Fig. 867.



Cystotome.

Fig. 868.



Paracentesis needle and curette.

Graefe's Operation, by Modified Linear Extraction.—In *senile cataracts*, extraction is the only allowable operation. Since the general abandonment of the old corneal-flap method, some form of Graefe's *modified linear extraction* is usually adopted. But each one practises the method of the great innovator with his own favorite deviations. This operation necessitates an *iridectomy*, which is a mutilation much to be regretted. But as its advantages more than compensate for the resulting deformity and less perfect vision, it should be accepted. The unanimous opinion of operators is that an incision at or a little in front of the sclero-corneal junction, is safer than one farther back and very close to the iris, as originally practised. Prof. Arlt, and a few others, still prefer to cut out under the conjunctiva, so as to get a protecting flap from it. The tendency, however, is to come out more in the cornea, and two methods are practised in which the deviation from the original operation is very great.

My own experience leads me to operate about as follows: I greatly prefer not to give ether, and only resort to it with extremely nervous or cowardly patients. The best preparation for this operation is *no preparation*, taking the patient in his usual health, and without waiting for him to work himself up into a mental stew of anxiety. As the patient must keep his bed for a few days, a good spring mattress should be provided. The patient is put comfortably in bed, in front of an unobstructed window, with a good light. There must be no head-board, or the head of the patient must be put to the foot of the bed, so that the operator or assistant may stand behind and meet with no impediment. The bed must be so placed that a direct and clear view of the cornea, without any disturbing reflex, may be secured, and no hand or head must be allowed to come before it. I prefer to operate without dilatation of the pupil. A suitable stop-speculum, fixation forceps, a Graefe's knife (Fig. 869), a cystotome with a hard-rubber or tortoise-shell spoon on one end (Fig. 870), a small curved pair of iris-forceps (Fig. 871), and a small pair of scissors (Fig. 872), curved on the flat, are the necessary instruments. Borated cotton, soft rags, and a bandage must be at hand. It is wise to have a strong solution of boracic acid, into which all the instruments should be dipped, and with which the eye should be well washed out. I have never operated under the spray, and consider it a vapory refinement. All things being ready, I talk kindly and frankly with the patient, telling him what to do and what not to do. He must promise to keep his mouth shut, not to hold his breath, and to listen to what the operator says, doing quietly as he directs. If he will keep his wits about him, and not resist, all will go more safely and easily. I never risk changing the fixation forceps to other hands, but hold them exclusively myself.

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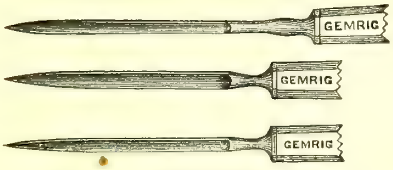
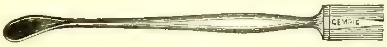
[1] See Fig. 858, page 199, *supra.*

Fig. 869.



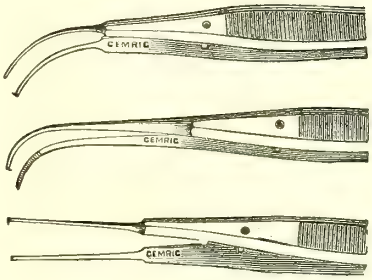
Graefe's cataract knives.

Fig. 870.



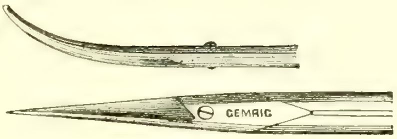
Graefe's tortoise-shell spoon.

Fig. 871.



Different forms of iris forceps.

Fig. 872.



Iris-scissors.

In extracting from the right eye, I stand or sit behind the recumbent patient's head, making the section with my right hand. Exchanging the knife for the iris-forceps, I draw the iris out, to be snipped off by the assistant. That done, I use the cystotome, and then turning the spoon end, make gentle pressure at the lower sclero-corneal junction, to bring out the lens. To operate on the left eye and still use my right hand, I sit on the side of the patient, directing him to put his left arm around me, so that I can get close in to his body. The assistant then stands behind his head, with the iris-forceps and scissors, draws out the iris with his left hand, and snips it with the right.

Then exchanging for the cystotome, he cuts the capsule and instantly hands me the spoon, which I use in bringing out the lens. In this case I can, and sometimes do, use the iris-forceps and the cystotome myself, the assistant simply snipping the iris. But the position is a little constrained, and I prefer the first method. To fix the eye, I use the large, broad-toothed forceps,[1] without spring to hold them closed, opening them three or four mm., and pressing them firmly on the ball, at the sclero-corneal junction, and then closing them so as to get a firm and controlling fixation. The point of fixing is not vertically below the cornea, but downwards and inwards, the extraction being usually upwards. I do this to better avoid the rolling of the eye on its visual axis, during puncture and counter-puncture. In old people with friable tissues, the conjunctiva sometimes tears, but it is not apt to do so if solidly and deeply held. I generally use the original stop-speculum of Graefe, and in case the eye is prominent, with danger of pressure, I direct a second assistant to hold the instrument near its temporal end and lift it slightly forwards. The smaller speculum, turned towards the nose side, is less in the way of the operator.

It is difficult, in describing this operation, to designate accurately the points of puncture and counter-puncture. Assuming, as an average, that the horizontal diameter of the clear cornea is twelve mm., I would say, let them both be exactly at the sclero-corneal junction, and one mm. above this diameter. In that way an incision of ten or ten and one-half mm. may be obtained, even if the knife cuts out a little in the transparent cornea. In passing the knife, I go straight through, without changing the direction of the point, simply watching it closely so as to make the counter-puncture at the right place. One is apt to make it further back than the point of entrance. This is a less dangerous mistake than the opposite, which gives too small an incision for the easy exit of the lens. The extent of the incision may be somewhat regulated by the approximately determined hardness of the lens and size of the nucleus. But there are always much greater dangers and difficulties connected with a too small, than with an unnecessarily long incision. These preliminaries settled, the steps of the operation may be briefly described. The knife should be introduced and kept with its surface parallel with the iris, being pushed far forwards, after the counter-puncture is made, so as nearly to complete the section, which is then finished as the blade is slowly withdrawn. Holding the cornea straight forwards or a little divergent, aids very much in this act. If the point of the knife catches slightly in the iris as it passes through the chamber, or if the iris falls over the edge, it is better to go right on and finish, than to hesitate and retract. Just before finishing the flap, it is best to turn the edge of the blade slightly forwards. In rare cases, where the eye is very deep-seated, the knife may be passed in with the edge inclined somewhat forward from the start, and made to cut out in the same plane, so as to prevent haggling of the wound. In that case we cut out farther forwards in the cornea. The section completed, we proceed at once to the iridectomy. If the iris prolapses, as it nearly always will, it needs only be seized, held firmly, drawn slowly out, and snipped off at one angle of the wound as close as possible. It is then drawn on a little more, carried towards the other angle and again snipped. On completing the excision, the angles of the wound are quickly inspected, and if any trace of iris hangs in either, it must be carefully seized with the fine forceps, drawn out again, and snipped close to the surface. If neither branch of the iris is drawn into the cornea, the straight, cut edges can be quickly recognized in the anterior chamber.

The next step, discission of the capsule, should be done quickly, so as to anticipate hemorrhage into the chamber. The very sharp cystotome, inserted flatwise with its point slightly upwards, is passed carefully down on the anterior capsule, till it reaches, or even passes behind, the lower edge of the pupil. Then, turning the point towards the capsule, it is drawn lightly upwards to the edge of the lens, making a vertical and long incision. This done, the curette or tortoise-shell spoon is placed with its convex surface against the lower edge of the cornea, and gentle pressure is made backwards. If in a moment the wound gapes, showing that the lens is engaging, the scoop may be slid slowly upwards over the cornea, till the lens escapes. Great gentleness is required at the last, to avoid loss of vitreous before the speculum can be removed. The moment the lens escapes, the stop must be loosed, the branches carefully brought together, and the speculum removed with great quickness and skill, so as not to press the eye. As a rule, I hold the eye with the fixation forceps till the lens escapes, and then instantly let go. In prominent eyes, or when escape of vitreous is imminent, we may let go the eye and remove the speculum the moment the iridectomy is finished and the capsule divided. Then closing the eye with a wad of charpie or cotton, for a few seconds, the lids are cautiously separated by the fingers, and by means of pressure through the lower lid the lens is made to escape. Or, the lower lid being well drawn down, the scoop may be used for pressure.

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[1] See Fig. 861, page 199, *supra.*

After the exit of the lens, the eye is shut for a few minutes, with a mass of cotton gently pressed on the closed lids. Then carefully opening it, a critical inspection of the pupil is made, to see if any soft cortical is left behind. If so, it must be carefully worked out, so as to secure a clear black pupil. To do this, request the patient to turn the eye down and try to hold it there. Then raising the upper lid above the incision, make careful sliding movements over the cornea from below upwards, through the medium of the lower lid. In this way the fragments may be slowly and very carefully coaxed out. If one or two trials do not succeed, let the eye be closed with a soft compress and bandage, for half an hour or more, till the aqueous reaccumulates. Then the same manœuvre will probably float out the soft fragments. The success of the operation will depend largely upon the ability to get away all the fragments from the chamber, and secure the most perfect coaptation of the incision. If any strings of coagulum, or shreds of capsule, hang in the wound, they must be removed with the small forceps. Without all these precautions, union by first intention cannot be expected, and the operation will be a more or less complete failure. The section should be ample and regular, and no iris or prolapsed capsule should be left in the cut.

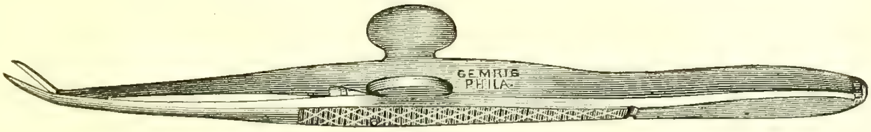
If a black pupil, free from blood, is secured, it is wise to test the vision by letting the patient count your fingers. Finally, both eyes should be closed by a roller so as to preserve their most perfect rest. A piece of old, soft cloth, large enough to cover both eyes, and torn at one edge to adapt it to the nose, is first adjusted. Then pellets of cotton are put over the eyes, to fill out the inequalities and make uniform pressure, and are followed by the application of the roller, which must not be tight enough to cause pain. For five or six hours, the patient, if possible, must lie very still, and flat on his back. If by that time, the bandage is at all deranged, let it be readjusted, without opening the eyes, and let the patient be kept quietly on his back till morning. Fresh dressings and bandage are then applied. On removing the soiled ones, if the lids are free from puffiness and the pads dry, all is well, and the eye should not be opened. Some swelling of the lids and yellowish discharge indicate dangerous reaction, and the eye should then be opened and inspected. In case the patient suffers little or no pain, and all looks promising, the dressings should be changed twice a day for two or three days, before opening and inspecting the eye. A careful night-nurse should watch the patient in sleep, to see that he does not hurt the eye. In a week or ten days the bandage may be removed, and a double compress be hung over the eyes, or a broad shade substituted. The room should be kept comfortably dark for some days after the operation, and the eye gradually accustomed to light. If all goes well, the patient may leave his room in about two weeks. If now a three and one-half inch lens improves the vision greatly, a good result is almost certain.

There are some troublesome accidents which no amount of experience and skill can always avoid. One of these is obstinate *hemorrhage* into the chamber, causing great difficulty in dividing the capsule, and perhaps preventing immediate vision. If the blood gathers in the chamber before the capsule has been opened, it may perhaps be coaxed out by a few strokes of the moistened curette. If not, the capsulotomy must be made by guess, carefully avoiding injury to the iris. If the chamber fills with blood after the exit of the lens, it will perhaps escape with the lens fragments under the sliding movement. If not, it can be safely left to the absorbents. *Loss of vitreous* before the escape of the lens is a very serious disaster, as it necessarily displaces the lens and makes its removal extremely precarious. A slight loss of vitreous following the lens, or in the sliding manœuvre to clear the chamber, is not so serious. Still, such loss always increases the immediate and remote risks. When the cataract is hypermature, or the incision too small, or both, the *presentation* may not be prompt. If this be due to the smallness of the section, that must be enlarged with the knife or the iris scissors, a procedure requiring great coolness and skill. Should the incision be free enough, and should the edge of the lens yet not come forward and open the wound, on moderate pressure with the scoop, the cystotome may be lightly passed in, its edge well forward, and drawn along the wound so as to divide the anterior capsule freely along the lens margin. Then the same pressure will eliminate it without serious trouble. If *suppurative reaction* comes on in twenty-four hours after an extraction, the eye will generally be totally lost. A milder reaction, at a later period, always protracts the cure, and generally leads to a membranous formation in the pupil, with imperfect vision. The suppuration begins in the corneal wound, at either end or in the middle, and thence proceeds to the iris and even the ciliary body. Careful springing of the incision once or twice a day, the free use of boracic-acid solution in the eye, the instillation of atropia two or three times a day, and the application of cold compresses externally, seem to be the best means of checking this sad process. In very old or feeble patients, warm fomentations or poultices do better than cold. Such cases, at best, end in closed pupil and a retracted cicatrix. In the worst forms, shrinking of the eyeball and even sympathetic danger to the fellow eye, may be the result. There is a well-grounded fear of sympathetic ophthalmia following the original operation of Von Graefe, where the section is made in the anterior part of the sclera, close to the periphery of the iris. The nearness of such a wound to the dangerous ciliary region, leads to greater risk of cyclitis and consequent sympathetic inflammation. Experience has led most operators to deviate from the classic method, and to make the incision at the base of the clear cornea, or even further forwards.

There is a popular impression that even after the most perfect success the cataract may return. This belief is based on the fact that sometimes the sight fails again in a year or two, very seriously. For example, with a vision of one-half, and the ability to read the finest print with ease, a mist slowly comes over the eye till the patient can only see to walk. This gradual clouding of sight is explained when the pupil is inspected by the ophthalmoscope, and by oblique illumination. A thin, grayish, filmy membrane is seen covering the originally clear pupil. This is not a reproduction of the lens, but a thin formation filling the rent in the capsule. In some cases this condition calls for relief, but if fair reading capacity is still left, I prefer to let the eye alone; otherwise, another operation is required.

These *secondary operations* to clear the pupil are by no means free from the risk of dangerous reaction. The thicker this capsular obstruction, and the longer it has existed, the tougher it will be, and the greater the difficulties and dangers of the operation. A very sharp sickle-needle may be passed through the cornea, and made to penetrate the capsule and incise it centrally. Or a Graefe's knife may be used for the same purpose. A safer and better method still, is that of Bowman's two stop-needles. One is passed through from the outer side, the other from the inner, both being made to pierce the obstruction at the same central point; then by a leverage motion of the handles, the needles are made to separate, each supporting the capsule for the other, and a central rent is made, with immediate clearing of sight. To do this with the greatest precision requires artificial oblique illumination. When the obstruction is thick, tough, and on a level with the iris, to which it may be adherent, a free incision with Wecker's scissors is the safest and surest remedy. A narrow spear-knife is made to puncture the cornea, and the closed scissors passed through the incision. As they are opened in the chamber, the pointed blade backwards, the obstruction is pierced and the blades pushed forwards, and then closed, so as to incise it freely in its centre. If it is cut at right angles to the direction of the greatest traction, the incision will open enough by its own elasticity. In some cases, with closed pupil and dense false membrane adherent to the iris, an iridectomy may be practised. In that event, however, a firm, pigmented, false membrane is seen behind the new pupil, and another operation will be required. I prefer to cut the whole structures at once by a free sweep of Wecker's *pince-ciseaux.*

Fig. 873.



Wecker's scissors, modified by Keyser.

In all these secondary operations, the danger of violent reaction comes from traction on the ciliary processes, in efforts to tear or incise the tough obstacle. For that reason, a skilful, two-needle operation, or an incision, is the least risky. After any of these operations the eye must be closed with a soft pad and bandage, and the patient kept quiet in a darkened room for a few days. Cold water applications, and anodynes internally, are the best remedies. Atropine, except in very filmy obstructions, without synechia posterior, is not beneficial. If persistent iridocyclitis, with pain, tenderness to the touch, and threatening sympathetic indications in the other eye, result from a cataract extraction, the offending organ must be enucleated. All these observations, based on the facts of experience, show that cataract operations of all kinds are not free from grave risks.

The lens in all cataract operations is destroyed; the eye is deprived of its accommodation, and is rendered extremely hyperopic. Suitable cataract lenses must then be worn for all purposes. If the proper glass does not help the sight very greatly, the pupil is not free from obstruction, or the visual capacity is impaired. Practically, two lenses suffice—one weaker ($3\frac{1}{2}$ to 4 inches focus), for distance, and one stronger (2 to $2\frac{1}{2}$), for reading and other close work. If the curvature of the cornea has been changed by the operation, a cylindrical lens may often be combined with the spherical with very great benefit. Cataract glasses are worn in heavy frames, as any other spectacles. It is better to wait six weeks or more before accurate trials are made to adapt the glasses, but a walking lens of four inches may be worn till that time if necessary. Great prudence in the use and the exposure of the eyes is required for months after the operation.

As already mentioned, the lens may be luxated in the eye, either from an injury or spontaneously. If this displacement takes place in the vitreous, leaving a free pupil and causing no destructive irritation, useful vision may be enjoyed by the aid of a cataract glass. If increased tension results, the glaucomatous hardness and threatened loss of sight may be relieved by a very careful iridectomy. Even an extraction may sometimes be practised, but at the risk of great loss of vitreous. In case all saving measures fail, the painful eye must be enucleated. Should the lens be knocked into the anterior chamber, or fall through the pupil, extraction is imperative. Spontaneous luxation of the lens is often seen in *coloboma* of the iris, with defective development of the zone of Zinn. I recall several curious cases of this kind. But even in the absence of any congenital deformity of the eye, family peculiarities exist which predispose to spontaneous luxation.

I have now under treatment a man, 48 years old. He felt some trouble in the right eye after lifting, and called for advice. There was ectopia of the lens downwards, the edge showing in the pupil, but with no pain or irritation. With a weak cataract lens the vision was two-fifths. At first the edge of the lens was at the centre of the pupil, but in three or four days the displacement downwards was complete; the eye remained comfortable, and the sight the same, for some months. Then one day, while he was stooping over a shrub, the eye was struck by the end of a twig; four days afterwards the eye was painful, tender to light, and weeping, the ball sore to the touch, with marked ciliary injection and discoloration of the iris, but no increase of tension. I prescribed a weak solution of atropine, and enjoined quiet. Next morning the eye was much better in all respects; but the same afternoon, while stooping for a book, he felt something "give way," and was suddenly blind. I found the lens, inclosed in its capsule and partially cataractous, in the anterior chamber. He was kept quiet for twenty-four hours, under the local use of eserine, and then the lens was extracted by a large corneal incision downwards. No vitreous was lost, but the iris prolapsed very slightly, the protruding portion being then snipped off. For some days the patient was kept in bed, and suffered a good deal of pain, but he recovered, with extraordinary vision, by the aid of a $+ \text{S } 9 \text{ d.} \asymp + \text{C } 3 \text{ d A } 45, \text{V} = \frac{7}{10}$. In his left eye, with a myopia of 6 d., he has a vision of $\frac{4}{10}$, the iris being tremulous, and there being some striæ of opacity in the lower and inner edge of the lens. Luxation will take place in this eye at some future time. In his family are five brothers and five sisters, seven of the ten having perfect eyes. One brother has a healthy emmetropic right eye, but in the left there is a complete luxation outwards, with confirmed glaucoma and hopeless blindness, the eye remaining comfortable. A sister has also one good eye, and one with luxation of the lens into the vitreous.

GLAUCOMA.

The essential characteristic of the fatal group of symptoms, called *glaucoma*, is increased hardness of the globe. The strong maintaining tunic is composed of the sclera and cornea. These two parts, physically so different, histologically are directly continuous, the fibres simply becoming transparent when passing into the cornea, and *vice versa*. When naturally distended by the inclosed transparent media, and the blood pressure of the choroidal and retinal vessels, the sensation given to the finger is called "normal tension." The healthy tone or elasticity of the eye, and the various deviations, can only be recognized by an educated finger. Education, here and elsewhere, is a tedious process, acquired and preserved only by constant practice. But how is the touch to be applied in this delicate investigation? The eye to be tested must be gently closed, turned towards the floor, and the head held slightly backwards. In this quiet way, the surgeon, sitting, facing the patient and in easy command of his own hands and arms, places the two index fingers, close together, on the globe of the eye above. The undivided attention must now be transferred to the pulps of these two fingers. While one is pressed with some firmness on the ball and held still, intermitting pressure is made with the other, as in feeling for fluctuation. The quiet finger detects the rise and fall of the fluctuating contents of the globe. The pressure should be directed perpendicularly to the surface, but not hard enough to produce pain. The natural eye is yielding and elastic. In high degrees of morbid tension it may be stony hard.

A convenient system of abbreviations has been adopted, to express the degree of tension: T_n, tension normal; $T^?$, tension doubtful; T_{+1}, T_{+2}, T_{+3}, indicate increased tension; $T-$, tension diminished; and T_{-1-2-3}, three degrees of softening. When there is great increase of intra-ocular tension, or the reverse, it is easily recognized. But slighter variations require great tact and attention. Both eyes should be examined in quick succession, transferring the fingers from one to the other. The hardness of glaucoma often varies at short intervals. The test should be applied every day, or oftener, so as to surely detect this important symptom at the earliest possible period, and watch its varying degrees. It is difficult to conceive how this pathognomonic symptom is brought about, except by hypersecretion of intra-ocular fluids, or by diminished exosmosis, or by both together. When these two processes are balanced in the nutritive changes within the eye, normal tension results. A natural secretion, with obstructed outward current, might produce increased tension. Hypersecretion, with free outward flow, might cause the same thing. But these two diseased conditions are usually united. What is the immediate cause, and whence the source, of this excessive secretion? Where is the seat, and what is the pathology, of the retarded exosmosis? Theories, and *facts* to *suit*, are by no means wanting. But none yet proposed, explains all the conditions of the glaucomatous process. Even the essential *fact* of glaucoma, increased tension, urged by Von Graefe as a satisfactory explanation of all the phenomena, has recently been denied. While perhaps always present in the advanced stage, it is said to be not essential to the existence of glaucoma, and not an initial symptom. The immense weight of authority, however, is on the other side, the differences of opinion being as to the origin of the increased pressure. Is the process a neurosis, or an inflammation, or both? The first was assumed by Donders as the best explanation. Others, claiming to have found traces of inflammation in the uveal tract and in the optic nerve, have put this forward as the forming stage, antedating increased tension. Increase in size of the lens, swelling of the ciliary processes, and diminution of the marginal space between the two, have been considered the first step in this disease. Retardation in the outflow of fluids from the eye, at the angle of the anterior chamber, followed necessarily by increased tension, explains the other phenomena. It is generally conceded that in most cases of glaucoma, there is compression of the angle of the anterior chamber, by a drawing forward and adhesion of the outer rim of the iris to the trabeculæ of Fontana's spaces. In this way a check of the current of intra-ocular fluids towards the canal of Schlemm and the surface of the eye, is produced. But whether this is primary and causal, or secondary, is still a much disputed question.

But with all this theoretical bewilderment, there is a sad general agreement in the prognosis, and the urgent necessity of surgical treatment in most cases. Just *how* an iridectomy or sclerotomy permanently relieves this fatal pressure, is as little understood now as in the time of Von Graefe. For accuracy of description, glaucoma is divided into simple, acute, chronic inflammatory, secondary, and hemorrhagic.

SIMPLE GLAUCOMA is chronic and insidious in its course, with very slow failure of sight, and is not attended by pain or inflammatory indications. For these reasons it generally escapes detection till the sight of one or both eyes is much impaired. The patient has always had an unaccountable difficulty in getting satisfactory glasses, has had to change them often for stronger ones, and at last cannot see much with any. If before, or at this time, he has sought medical advice, he has probably been told that his disease was cataract, and that he could not be operated upon till he was blind!

As glaucoma and cataract often exist together, and are both especially diseases of advanced years, this fatal error of diagnosis is all the more easy and common. The senile change of color in the lens to a grayish or amber hue, whether the eye is glaucomatous or not, readily imposes on the careless or incompetent surgeon.

In addition to rapid failure of accommodation and trouble with glasses, smokiness of vision, fluctuating but slowly increasing, comes on, and the patient remarks a colored halo around the lamp or candle at night. These vague troubles often persist for years before he seeks competent advice, and is told that he is going hopelessly blind. If vision is already greatly reduced, the pupil will be unduly large, and sluggish in response to light. The anterior chamber is shallow, the tension exaggerated, visual acuity diminished, and the field of vision contracted, sometimes concentrically, but usually more on the nasal side. Rarely there may be a central scotoma.

In this form of glaucoma, the humors are perfectly clear, and a most important ophthalmoscopic symptom is detected. I mean *cupping of the optic disk.* The eye end of the optic nerve yields to the increased internal pressure, and gives rise to this characteristic symptom. The cup or excavation involves the entire disk, or nearly so, and looks very different from the small central pit present in all healthy eyes. The edges are abrupt, and the main trunks of the retinal vessels seem suddenly cut off, as though cut out with a punch. Those who explain this symptom by a retraction of the optic nerve from previous inflammation in its sheath and texture, of course attach less importance to the pressure. As the few large trunks of the retinal vessels radiate from the optic-nerve centre, when this surface is pressed back and converted into a pit, these vessels will be suddenly bent as they dip down into it. The bottom of this pit being out of focus when the edges are in focus, they seem to be cut off. But when the bottom is focused, they are distinctly seen going to its centre, and, by looking obliquely, they may be traced down the abrupt sides. The difference in the glasses required to bring into sharp view the retinal margin of the excavation and the bottom of the cup, is an accurate measure of its depth. Another symptom, often present, is visible pulsation of the arterial trunks on the disk. If this is not seen spontaneously, it may be developed by very slight pressure on the ball with the finger. Swelling and falling of the veins, synchronous with the heart's movements, may often be seen in healthy eyes, but pulsation of the arteries is never seen except in disease. Undoubted hardness of the eye to the finger, cupping of the disk, and pulsation of the retinal arteries, are infallible evidences of glaucoma. Of course, the history and other symptoms mentioned, must not be forgotten. The lamina cribrosa of the sclera resists more in some than in others, and hence the cup varies in depth even with the same pressure.

At times enormous cups may be detected, with slight increase of tension, and at others extreme hardness and great damage to sight, with little or no pit. If the pressure has come on very slowly, the vision fails less rapidly. The damage to sight is due to the paralyzing effect of undue pressure on the conducting fibres of the optic nerve, their sudden flexure in the pit, and the impaired retinal blood supply. Mauthner denies this usual explanation, and insists that the functional failure is due to disease of the choroid affecting the rods and cones of the retina. Sometimes the natural brilliancy of the iris, the activity and average size of the pupil, and the outward appearance of the eye are so little changed, that the increased hardness, cupping of the disk, and failure of vision, are the only positive symptoms. But these are sufficient to settle the diagnosis. While glaucoma simplex may last for years and lead to total blindness without any inflammation at all, this painful complication is apt to occur, especially in the advanced stages of the disease, when it adds to the torment of the hopeless loss of sight.

ACUTE GLAUCOMA is always inflammatory, and often excessively painful, extinguishing sight in a few hours or days. The epithelium of the cornea is altered, the aqueous turbid, and the vitreous cloudy and showing floating corpuscles, so that the fundus cannot be seen with the ophthalmoscope. Intense episcleral injection, chemosis, puffiness of the lids, and excruciating pains in the eye, circumorbital region, and head, with perhaps nausea and vomiting, make up the frightful picture. Of course the ball is intensely hard, with insensibility of the cornea to light touches with a brush or probe. Indeed, anæsthesia of the cornea is present in greater or less degree in all forms of glaucoma. It is due to paralysis of the sensory corneal nerves from pressure. Acute glaucoma is sometimes preceded, for weeks or months, by prodromic symptoms, such as temporary blurring of vision with increase of tension, some vague feeling of discomfort or actual pain, and more or less injection. These significant symptoms intermit, leaving the sight better in the intervals. But they come oftener, last longer, leave the sight each time worse than before, and end at last in a destructive attack of acute inflammation. More rarely, the disease bursts out in all its violence without previous warning, in *glaucoma fulminans.*

CHRONIC INFLAMMATORY GLAUCOMA develops slowly like the simple variety, but always with symptoms of vascular reaction. With the peculiar hardness of the eye, there are cupping of the disk and pulsation of the arteries, if the humors are clear enough to admit of ophthalmoscopic examination. Beginning in one eye, it finally attacks both, but sometimes after a very long interval. Von Graefe believed that the occurrence of the disease in the second eye was hastened by iridectomy in the first. I believe this to be a mere coincidence, but the non-affected eye should be constantly watched, so that an iridectomy may be resorted to at once, if the necessity should arise. The varicose, inosculating loops of bloodvessels around the cornea, are very striking in the inflammatory forms of glaucoma. The advanced stages of all the varieties, when sight is extinguished, the ball stony hard, the pupil widely dilated, the iris atrophied and reduced to a narrow rim, the sclera of a grayish, leaden color, with large loops of tortuous veins, loss of tactile feeling in the cornea, and often cataract, are called *glaucoma absolutum.* In this pitiable condition, repeated and painful intra-ocular hemorrhages take place, the insensible cornea may slough, and the eyes may be reduced by atrophy of the globe. In the absolute glaucoma which follows the simple variety, the deep excavation of the optic nerve and excessive tension may be the only means of distinguishing it from hopeless atrophy of the optic nerve.

SECONDARY GLAUCOMA.—In the former varieties, the destructive hardness, with its long list of fatal consequences, seems to be *primary.* In this it develops in the course of numerous other diseases, and is hence called *secondary.* A frequent causal connection exists between increased tension and synechia anterior from perforating ulcers of the cornea. Luxation of the lens, spontaneous or traumatic, almost surely leads to glaucomatous manifestations, probably through irritation of the iris and the choroidal tract; and so may fragments of a broken-up lens. Total synechia posterior, cutting off communication between the two aqueous chambers, generally leads to destruction of sight from glaucoma. Serous iridochoroiditis is very apt to lead to secondary glaucoma. Intra-ocular tumors of all kinds give rise to increased tension at a certain stage of their growth. In all forms of ectasia of the eyeball, congenital or not, leading to great enlargement of the eye—hydrophthalmus—the sight is surely destroyed in the end by glaucoma. In such cases, enormous excavations of the optic disk are usually found.

HEMORRHAGIC GLAUCOMA.—The most hopeless form of glaucoma, primary or secondary, is the *hemorrhagic.* The retinal hemorrhages are apt to take place suddenly in the central region and around the optic disk. At first it is difficult to foresee what the ecchymoses indicate, but the increased hardness tells the story. Such hemorrhages, often seemingly without cause, in persons of advanced years, are very apt to be the forerunners of this most pernicious and unmanageable form of glaucoma.

TREATMENT OF GLAUCOMA.—Every glaucomatous eye, when left to itself, terminates in hopeless blindness. The immortal discovery of Von Graefe made an epoch in the history of human sorrow. Till iridectomy was found to be a reasonably certain remedy for the morbid hardness of the globe, but the one sad fate awaited every such case. But we know as little still about the way in which this operation permanently reduces the intra-ocular tension, as we do of the immediate cause of the increased pressure. The success of the treatment, however, in the majority of cases, is not now disputed. Since that forward stride in the therapeutics of this process was made, it has been discovered that eserine and pilocarpine, in addition to their action in contracting the pupil, possess the power of reducing the tension of glaucoma, and, in rare cases, permanently. Usually, however, the action is transient, and in the chronic forms not even temporary relief is afforded; so that we are forced to fall back upon surgical treatment at last. The earlier iridectomy is practised, the greater is the certainty of saving useful sight; hence the immense importance of an early diagnosis. Every surgeon and physician should be able to make the diagnosis promptly, and thus avoid delay. The section, for cosmetic and visual reasons, is generally made upwards, so that the mutilation of the iris shall be covered by the upper lid. An incision, of from 6 to 8 mm., is to be made at the sclero-corneal junction, as near the periphery as possible. This is best done by a Graefe's cataract knife, especially where the chamber is very shallow, as it certainly will be in many cases. The puncture and counter-puncture must be made as in the incision for extraction of cataract, and the point of the knife closely watched as it traverses the chamber, close in front of the iris. If the iris prolapses on completing the section, it may be seized by the fine, toothed forceps, drawn well out, and held steadily till cut off with scissors close to the sclera. Two snips are required, beginning at one end of the incision and finishing at the other, the assistant pulling the iris a little tighter after the first snip. The object is to excise a broad portion of the iris reaching quite to the periphery. Should no prolapsus occur, the closed forceps must be passed carefully into the chamber, opened well and closed again, thus seizing and slowly drawing out the iris. The previous use of eserine, to contract the pupil as much as possible, facilitates the operation, and diminishes the risk of wounding the lens capsule. After the iris has been properly snipped, the eye should be instantly shut, and gentle compression made, to avoid intra-ocular hemorrhage. After a few minutes let the eye be carefully opened and inspected. If any iris remain imprisoned in either angle of the cut, it must be seized, stretched, and snipped off. If the scleral section is not freed from iris, trouble and doubtful relief are to be expected. Of course, the wire speculum and the fixation forceps are always necessary, and, in most cases, etherization. The same steps and precautions are to be taken as in Graefe's method of extraction, except that the incision into the anterior chamber is shorter. The suspensory ligament and capsule of the lens must not be injured; the eye should be kept lightly bandaged, and the patient quietly in bed, for a few days.

In *acute glaucoma*, this operation, executed properly, and within a few days, shows its greatest triumphs. The longer it is delayed, the greater doubt as to success. In most cases of *chronic*, *simple glaucoma*, it fails to save useful vision, but the patient should have the only chance. In *chronic*, *inflammatory glaucoma* it promises better, but often fails to afford permanent benefit to sight. It relieves tension generally, and saves the patient from much suffering in the future, at all events. In both these varieties, it is sometimes necessary to do a second iridectomy, below and opposite the first, to achieve permanent softening of the eye. In *secondary glaucoma*, in addition to removing the cause as far as possible, an iridectomy should always be done, and will often succeed in saving the eye. For *hemorrhagic glaucoma* the operation should never be risked. Immediate extinction of sight from profuse intra-ocular hemorrhage would be almost sure to follow, and, even if it did not, the vision would be lost at last. Of course, in confirmed glaucoma, where no hope of sight can be entertained, the operation should be avoided, except, it may be, to relieve extreme pain. Its execution is then very difficult, and enucleation will at last give the safest and surest relief from suffering. In rare cases of glaucoma simplex, and in other more promising forms, the best executed operation may be followed by rapid and complete loss of sight. While this possibility should be remembered, it should not deter us from a resort to the only hope of relief.

The theory that explains the mechanism of operations for the cure of glaucoma by the filtration cicatrix, has suggested *sclerotomy*. A larger experience with this method must decide on its comparative merits. If any operation is to be performed in hemorrhagic glaucoma, this is the safest and the only one to be recommended. In the chronic and doubtful forms, it may also be tried, as well as in confirmed cases. It certainly removes the peculiar hardness of the globe in some cases, and may, on fair and large trial, replace iridectomy. But the latter has the firmest hold on the confidence of all but a few operators. The object in sclerotomy is to avoid mutilating the iris, and to prevent it from prolapsing into the incision. To avoid this, eserine is freely used before the operation. The first steps are precisely the same as for iridectomy. After counter-puncture, the knife is moved slowly backwards and forwards till the scleral incision is nearly completed. Then it is slowly withdrawn, allowing the aqueous to trickle out very gradually, so that the iris may not be washed into the wound. If it prolapses, the rubber spatula may be used to replace it. Eserine and friction over the cornea, through the medium of the lid, may reduce it. If this cannot be done, it will be better to draw the iris out and snip it off. The eserine treatment may be beneficial in relieving any hardness that sometimes persists after the surgical treatment.

Again I would warn against the unpardonable sin of mistaking glaucoma for cataract, and of using atropine in its treatment.

Strabismus.

Definition and Varieties.—Strabismus consists in an inability to fix both eyes on the same point, at the same moment, not due to paralysis. The two eyes move freely together or separately, but one deviates constantly in the same direction and to the same degree. *Convergent* squint, in which one eye turns too far inwards while the other fixes, is the most frequent variety. *Divergent* strabismus, in which the deviation is outwards, is next in frequency. Deflection *upwards* or *downwards*, is of rare occurrence. Strabismus is a deformity, and excludes the benefits of binocular vision. The constant direction and degree of deviation in all possible positions of the eyes, establish the most important diagnostic difference between squint and faulty fixation from paralysis. In the one, the erratic eye, when solicited, turns freely in every direction. In the other, it cannot be budged in the direction of the paralyzed muscle.

Let us assume a convergent squint, in the left eye. Cover the right with a card and compel the faulty eye to act. It will fix and follow the finger wherever normal fixation is possible. But the right eye will now squint behind the card. This forced, secondary deviation will be exactly the same in direction and quantity, as the primary. But simultaneous fixation is nowhere possible. In paralysis, binocular fixation may be easy in all directions but one, and the secondary displacement will be much greater than the primary. In no part of the body are delicate disturbances of muscular equilibrium so quickly detected, and so annoying, as in the rotary muscles of the eyes. The constant double vision cannot be ignored.

Should a given convergence be due to paresis of the external rectus, not only distressing diplopia, but more or less limitation in the outward movements of the eye will be detected. As before, suppose that the left eye converges when both are open. Cut off the right with a card, and the left will follow the finger readily, except when moved to the left. While soliciting movement in this direction, and without avail, notice the right eye behind the card. It will turn in excessively, almost burying itself behind the nose. Both eyes being open, the patient will see double in all points to the left, but single to the right. Instinctively, he learns to avoid the horrible diplopia, by turning the head constantly to the left, thus bringing objects to his right. In deviation from paralysis, there are constant errors of projection and consequent giddiness, except when the faulty eye is closed. If the patient tries to walk with the perfect eye closed, he will stagger. In the case assumed, close the right eye, and holding your finger to the left of the patient, tell him to touch it quickly with his index finger. He will constantly thrust to the left of it.

The degree of strabismus may vary from a mere *cast*, to a deviation of ten mm. or more, constituting a hideous deformity. The linear deviation may be measured with sufficient accuracy, as follows: Shut the non-squinting eye, and request the patient to fix your finger, steadily held about ten inches in front of his nose. Then, with a pen, mark with ink the point of the lower lid that corresponds to the centre of the pupil. This done, open the other eye and tell him to fix the same finger, held in the same position. The eye will now deviate and an ink spot is again made to correspond to the centre of the pupil. The distance between these two ink spots will be, in millimetres, the linear deviation. In the earlier periods of strabismus, when it is often intermittent, there is perhaps always double vision. But by a mental process of abstraction, the patient soon learns to ignore or suppress the image of the crooked eye, and thus gets rid of the horror of diplopia. This process is favored by a variety of circumstances. If the squint begins as early as the first or second year, before the habit of binocular vision is solidly formed, the habit is soon broken up in the interest of single vision. Children learn and unlearn habits far more readily than older persons. Then one eye is often much more imperfect in sight than the other. It is a fact that many children are born with this difference, and that many such become strabismic. In that case, the child squints with the naturally defective eye. The more marked the difference in distinctness of vision between the two eyes, the easier it becomes to fix the attention exclusively on the sharp image, and to ignore the dim one.

In the great majority of cases of confirmed squint, except when it is alternating, the constantly deviating eye will be found defective in sight. The amblyopia is often so great that the patient cannot read even capital letters. The fixing eye will be found better, and generally perfect in sight. It has long been assumed that the defective vision in such cases is due to disuse of the eye—*amblyopia ex anopsia.* While this may be true in part, there is reason to believe that in many cases the defective sight has existed before the deviation, and has played, perhaps, an important part in determining it. According to Schweigger, for one hundred and seventy-seven strabismic patients with one-sided amblyopia, there will be found ninety-eight with a similar visual defect in one eye, without strabismus. Of these ninety-eight patients, forty-seven per cent. will be found hyperopic, showing that hyperopia and amblyopia may exist together, without giving rise, necessarily, to squint. It is quite probable that the long-continued disuse of the squinting eye may increase a natural and pre-existing defect of vision. In consequence of this disparity, binocular vision may never have been learned at all, or but imperfectly, and in case of squint, it is readily unlearned. Strabismus is essentially a disease of childhood or early life, while paralytic affections prevail more among adults, where single vision with two eyes has become a long and imperious habit. A confirmed habit, good or bad, is hard to shake off, however important the interests involved. Hence the diplopia of paralysis is constant and very harassing, and it persists as long as the cause endures. In intra-uterine paralysis or congenital absence of one of the recti muscles, diplopia never occurs. Persons thus affected learn to blend the images where both eyes command the field, and to suppress that of the lagging eye in other directions. I recall the case of a woman, forty years old, whom I treated for *retinitis albuminurica*, from which she recovered with perfect vision in both eyes. I discovered that the right eye could not be rotated outwards at all, and expected to find corresponding diplopia with exaggerated secondary deviation of the left eye. But neither symptom had ever been present. It had always been so, and I found binocular vision in the median line and to the left, and monocular single vision to the right. In looking at objects to the right, she used the left eye and suppressed the image of the right. I have recently examined a young man whose eyes present a similar condition of affairs.

Causes of Strabismus.—Till the time of Donders, the etiology of squint was a matter of vague conjecture. The most absurd explanations were often detailed with great assurance, and still are, even by some physicians. Donders demonstrated that in two-thirds of the cases of convergent squint, there was hyperopia, an anomaly of refraction imposing constant strain of accommodation. The constantly associated actions of convergence and accommodation, and the possibility of exaggerating either by emphasizing the other, were so fully elucidated by him, that little positive knowledge has since been added. His theory, based on the physical fact of hyperopia, was that the excessive convergence of one eye enabled the other to focus successfully for close work, in spite of the hyperopia. The theory demands that *all* hyperopes should become cross-eyed, and in proportion to their degree of hyperopia. But this does not prove true in fact. As a rule, the degree of hyperopia in convergent squint, is not excessive. Some patients with extreme degrees of hyperopia squint, and some do not, but hold the book very close, as if myopic. There are many persons with hyperopia in varying degrees, and often with congenital defect of sight in one eye, who never squint. Again, some emmetropes are victims of strabismus, both convergent and divergent. Even hyperopes are found affected with divergent strabismus, and myopes with convergent. Hence there must be some other cause, besides an anomaly of refraction, which determines it in one case and not in another. What can this be, and where can it attach, except to the *muscles* themselves? In many cases, marked insufficiency of one rectus muscle exists, and yet no manifest strabismus ever develops in its antagonist. The impulse to, and predominating interests of, binocular vision, dominate the want of balance, and keep the eyes straight. But exclude one eye from the visual act, and the disturbed muscular equilibrium will show itself at once. Direct the eyes to be fixed on the point of a pencil, at eight or ten inches, and then slip a card in front of one eye. The excluded eye will swing inwards or outwards, and twitch quickly back into position when the card is removed. As a rule, the preponderance falls on the side of the internus in childhood, and of the externus in later years.

Such cases of insufficiency are sometimes called latent squint, but improperly. So it seems that disturbance of the natural muscular balance alone, is not enough to determine strabismus, especially when the vision is perfect in both eyes. Again in adults, associated with hyperopia we often find insufficiency of the interni, but without strabismus. Such patients complain of pain and fatigue on close application of the eyes, and often shut and press on them for relief. This is muscular asthenopia, aggravated by hyperopia, and yet with no manifest squint. Binocularly, they fix and see single, but exclude one eye, and it deviates outwards. Direct such a patient to fix both eyes on a pencil, constantly approaching the nose. At six inches or perhaps nearer, one eye will swing outwards and the pencil appear double, with crossed images. Tried by other tests the same insufficiency of the internus will show itself, and yet the patient does not squint. Physiologically, the relative power of the two muscles is largely in favor of the internus. In ordinary avocations, the interni are in almost constant use, converging the eyes for finite distances. The external, at most are only called on to reduce the eyes from convergence to parallelism. Hence the far greater strength of the internal recti muscles. A glass prism before one eye, with its refracting angle towards the nose, produces double vision by deflecting the image towards its base. Single vision can only be restored by an extra action of the internal rectus, converging the eye behind the prism. If the prism be reversed, diplopia will again ensue, and the external rectus is called on to relieve it. The strongest prism that either muscle can thus overcome, in the interest of single vision, will be a reasonable measure of its strength. It is much easier to overcome strong prisms at ten or twelve inches, than at twenty feet. Ulrich suggests that it is well to test the eyes for an object at twenty-five centimetres (about ten inches), and at six metres (nearly twenty feet). In emmetropes, a No. six or seven prism can be neutralized by the externus, but one very much stronger by the internus. Ulrich gives the average normal power of the converging muscles at forty-five, and assumes pathological weakness when they cease to neutralize a prism of twenty-five to thirty. Starting from these premises to investigate the relative muscular strength in hyperopes, where convergent strabismus does not exist, Ulrich concludes that all patients with hyperopia, who do not squint, have insufficiency of the internal recti muscles.

This original difference in muscular balance would seem to account for the fact that a blind eye, in course of time, will sometimes converge, at others diverge, and at others remain straight. The same explanation applies to the occasional occurrence of either convergent or divergent squint in emmetropes. Even hyperopes sometimes become victims of divergent strabismus. I am treating a young man who, when he came to me, had a divergence of ten mm., and who habitually fixed with the right eye, for all distances. In that eye he was myopic three dioptrics (twelve inches). Of course his vision for distance was very imperfect, and he had never worn glasses. With a correcting concave glass, the remote vision was perfect. To my surprise, when the right eye was covered, and the divergent, left eye brought to bear, his distant sight was found perfect, and the eye emmetropic. Yet he constantly fixed with the right eye and suppressed the image of the left, seeing very poorly at a distance, and reading well and exclusively with the myopic right eye. I have frequently seen patients with one near-sighted and one long-range eye. But they fix distant objects with the one and read with the other. How shall we account for the remarkable exception presented in this case? I can explain it by supposing that, when the strabismus developed ten years ago, both eyes were emmetropic and equal in vision. But the patient learned to fix constantly with the right eye, and to suppress the image of the left. At last myopia developed in the eye constantly used, and the old habit of exclusively fixing with it persisted. He remembers that distant vision has become very much impaired in the last three years. I have divided in succession both external recti, and have thus greatly reduced the degree of divergence. Since the last operation he has learned to fix distant objects with the left eye, while he still reads with the right, having gained very greatly in range of vision. By an advancement of the internal rectus of one eye, I expect to correct the remaining divergence.

A long experience has taught me that insufficiency of the interni is one of the most troublesome complications in non-squinting hyperopes. In them we have to combat muscular and accommodative asthenopia at the same time.

Etiology of Divergent Strabismus.—In the great majority of cases, divergence of the eyes is seen in myopic subjects. In these, the increased size of the globe antero-posteriorly, is caused by bulging of the back part of the eye. The direction of this staphyloma posticum is such as to favor the power of the externi. Such persons have little use for their accommodation. Hence convergence is not dominated by the focusing impulse, as in other forms of refraction. Myopes of high degree must bring objects very near in order to see them sharply. The resulting, painful degree of convergence, unaided by impulses of accommodation, cannot be maintained for protracted, close work. Soon one or the other eye turns outwards, and monocular vision is adopted. The amount of myopia, as well as the acuity of vision, often differs in the two eyes, making prolonged binocular fixation still more difficult. The most myopic and defective soon yields to the pressing tendency, and diverges. But here again some other factor, besides the state of refraction, is required to explain the occasional presence of myopia without divergent, or even with convergent, strabismus. The original, relative length and strength of the externus and of the internus, have something to do in bringing about strabismus. The chapter on the etiology of strabismus, in all its details, is not yet written.

TREATMENT OF STRABISMUS.—It is well to remember that some cases of squint recover spontaneously. In my observation, however, such cases are very rare.

The few recoveries that I have seen, have been only partial, some appreciable deviation being still detected. It is chiefly in convergent strabismus that these favorable changes take place, with the progress of years and the disappearance of active accommodation, and though I cannot agree with De Wecker, who asserts that the majority of cases of convergent strabismus get well spontaneously, if let alone, still, the dominating influence of accommodation over convergence in early years, and its subsidence in advanced years, should not be forgotten. In intermittent squint, beginning in childhood, and being the first stage, often, of fixed deformity, it is sometimes possible to effect a cure without operation. The cross is only noticed when the child looks closely at small objects, or is embarrassed, or perhaps deranged in health. Appearing more and more frequently, at length permanent contraction of the prevailing muscle is the result. This variety is frequent in hyperopic children, and shows itself about the time they are put to school. If the sight is equal and perfect in each eye, the prospect of cure by hygienic and medical treatment is greatly enhanced. But equality or perfection of sight, at this early age, before the child knows its letters, is very difficult to determine. Still, an effort at cure should be attempted. The well-known influence of spasm of the ciliary muscle in exaggerating convergence, should be neutralized. This is best done by instillations of atropia. One or two drops of a one-grain solution, may be safely dropped into the eyes of the child twice a day. Often little or no tendency to squint will show itself while this treatment is kept up, and by perseverance for weeks or months a permanent cure may be brought about. Homatropine in stronger solution (four grains to the ounce) can be used in the same way, and is less likely to produce constitutional disturbance. Eserine has likewise been tried for the same object. Its action is to stimulate the accommodation, and thus enable the eyes to overcome the hyperopia without excessive convergence. But in children under five years, in which this treatment promises best, one cannot risk the constant use of convex glasses to neutralize the hyperopia while the atropine treatment is carried out, and afterwards. Strabismus that can be controlled by atropine or by glasses, or both, if operated on, will probably show divergent eyes in after years. All close use of the eyes for study must be interdicted, and the use of tonics, aided by fresh air and good regular diet, enforced. Goggles and other devices cannot correct the squint, but may be of use in compelling separate exercise of the eyes.

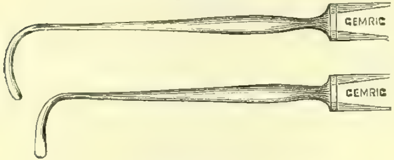
Training with the stereoscope, as recommended by Javal, involves a degree of intelligence and attention not possible in children. Confirmed strabismus, not controlled at all by atropine and convex glasses, demands surgical interference, and the earlier it is resorted to the better the success. There is no deformity where a timely and skilful operation is so certainly successful. In the few cases in which tenotomy produces little or no effect, a proper advancement of the antagonist muscle secures the end desired. These two operations may often be happily combined. But great circumspection, skill, and patience, are required to secure an abiding, good result. The zeal of inexperienced operators to obtain an immediate and complete correction, often leads them to do a double tenotomy at once. This may be very gratifying to the parents or friends, and secure a cheerful honorarium, and yet may be a curse to the patient in the ultimate course of life. Insufficiency of the severed muscles, and unsightly divergence in after years, may drive the patient to wish that his benefactor, now perhaps happily dead, had never lived! Such a deformity is far greater and more difficult to remedy than the original squint. A rightly proportioned and skilfully executed advancement, however, may triumph even over these unfortunate excesses. What operator of long experience has not had these dilemmas with divergent horns, come back on him in the winter of his discontent? Perhaps more of them fall into other hands. Thoughtful operators proceed with great prudence, preferring too little immediate effect to excessive remote results. A slight remaining convergence attracts little notice, and may disappear with age, as presbyopia develops. The aim should be to attain the best possible correction, with the least insufficiency and disturbance in the binocular movements. Then again, a desire to correct an extreme degree of convergence by operating only on the *crooked* eye, making the dissection very extensive, or repeating the operation on the same eye, is often disastrous. Marked insufficiency of the weakened muscle, undue prominence of the eye, sinking in of the caruncle, and great disparity between the eyes, will result. Besides, if the operator has not taken the precaution to detect and demonstrate to the parents the already defective sight in the faulty eye, he will get the additional credit of having destroyed the sight by his operations! Slight degrees of squint may indeed be relieved by one judicious operation. But in the great majority of cases of higher degrees, it is far better to operate on both eyes, at intervals. In very extreme cases, however, a simultaneous, double tenotomy may be safely done, and it is sometimes the only way to get sufficient correction.

As a rule, it is wiser to operate first on the worse eye, and then wait a few days or weeks for the definitive result, before attacking the other. In all serious undertakings, "make haste slowly" is a safe injunction. Of course this does not suit the *itinerant operator*, but I am speaking of honest and conscientious men. The object to be secured is the detachment of the tendon from its scleral insertion, so that it may retract and readhere farther back. We want to weaken, but not to destroy its rotating influence. The second insertion must be within the capsule of Tenon, else the result will be excessive. But the immediate effect of a skilful tenotomy will vary in different cases. When the eyes are deep-seated and small, a much bolder operation may be risked than where the contrary obtains. In the former case, some degree of exophthalmus, especially if equally divided between the two eyes, is desirable. Then again, the blendings of the tendon with the capsule of Tenon, as it passes through, vary in extent and rigidity. The same is true of the tendinous attachment to the sclera. Moreover, the amount of correction depends more on the active energy of the antagonist than upon the retraction of the severed muscle. A greatly stretched and weakened antagonist is not likely to assert itself and produce a marked immediate effect. We must not only measure, as exactly as may be, the linear deviation, but the extent of possible movement inwards and outwards. In convergence, the possible rotations inwards are excessive, and the outward rotations somewhat limited. In divergence the contrary obtains. By requesting the patient to fix your finger with both eyes open, and moving it far to one side and then to the other, you test the extent of rotation in these opposite directions. The margin of the cornea and the outer commissure of the lids are the external land-marks. The inner margin of the cornea, as compared with the lower punctum, will be the guide for inward movements. Sometimes the centre of the cornea can be drawn so far beyond the punctum, that it is nearly buried out of sight. In such a case, with a weak external rectus and marked limitation in the outward rotations, one can scarcely get too much effect from the tenotomy. Indeed, it may be necessary to combine with it, advancement of the externus. We want to diminish the excessive motion in one direction, and increase it in the other, so as to restore a natural equilibrium. The nice point is to insure the needed correction with the least muscular insufficiency. If you correct the position completely, with marked muscular insufficiency, an opposite deformity in after years is almost certain. The limitations of the weakened muscle must be tested as soon as possible after the tenotomy.

If the patient has been put under the effect of ether, time must be given for this to pass off. This sometimes causes embarrassing delay. If the extreme possible rotation, noted before, has been positively reduced, the muscle has been completely severed. Otherwise, perhaps not, and the wound must be explored further, and the eye then tested again. As a rule, I desire to see enough power left in the internus to bring the edge of the cornea to, or even a trifle beyond, the punctum. Should the movement inwards be more limited, the judicious use of a suture will be required, but in most cases this will not be needed.

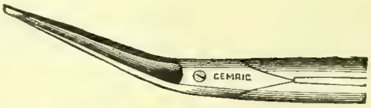
The instruments necessary for this operation are a stop-speculum (Fig. 860), a pair of toothed forceps for picking up the conjunctiva, two strabismus hooks, a large and a small (Fig. 874), and blunt but very sharp scissors (Fig. 875). The scissors may be straight, or bent on the edge. I prefer them straight. A very soft, clean sponge is likewise to be provided. Then comes the question of ether. For a great many years, I have very rarely used chloroform, and only when there was peculiar trouble in securing complete anæsthesia. Ether must be pushed rapidly, and the air excluded, else thorough insensibility cannot be produced. This is the only way to secure the needed quiet, at the least risk to life; and if the first moment of sudden unconsciousness be seized for the operation, the patient need not take much ether, nor be kept long under its influence. In all cases in adults, I urge that anæsthesia be not employed. The operation is quickly over, not very painful, and free from danger, and we can then at once test the effect secured by the tenotomy. With timid people, who have no self-control or confidence, and with children, we cannot do without an anæsthetic.

Fig. 874.



Strabismus hooks.

Fig. 875.



Strabismus scissors.

The patient should lie on his back, on a lounge or operating chair, with the head thrown slightly backwards. When the stop-speculum is adjusted, the first steps of the operation are facilitated by forced rotation of the eye directly outwards. This is effected by an assistant, who fixes the eye near the outer margin of the cornea, in the horizontal meridian. Great care must be taken not to rotate the globe on its antero-posterior diameter, else the relation of the incision to the tendon will be altered. I generally employ the subconjunctival operation. The conjunctiva is seized with the small toothed forceps, about three or four mm. from the inner edge of the cornea, and as nearly as possible over the lower edge of the expanded tendon to be detached; and it is then divided with the scissors, horizontally backwards, far enough to afford room for the further steps of the operation. It is next detached by a few movements of the points of the scissors over the seat of the tendon. Then letting go the conjunctiva, the capsule of Tenon is seized through the conjunctival opening, the forceps being pressed with a little firmness on the sclera, and is opened and detached to the same extent. The forceps still holding and raising the detached conjunctiva and capsule, the large hook is next passed in,.pushed backwards, and the point swept from below upwards under the tendon, being pressed firmly on the sclera in this movement. This is the most difficult and important manœuvre, next to detaching the tendon, and its successful execution greatly simplifies the rest of the procedure. The firm resistance felt, when the expanded tendon is thus gathered in the concavity of the hook, is the assurance that it has been secured.

Drawing the hook forwards till it is arrested by the tendon at its insertion, it is held firmly, and the tendon is then divided by a few snips of the scissors from below upwards, subconjunctivally. Then the same or the smaller hook may be swept upwards, to be sure that no fibres of the tendon above have escaped; and likewise downwards. If, when this is fairly done, the hook comes forwards under the conjunctiva, close to the cornea, meeting no resistance, it is sure that the tendon is entirely detached. By loosening it between the hook and the sclera, and as close to the latter as possible, there is no serious sacrifice of the tendon.

If ether has not been used, the effect can be tested after a few seconds of closure of the lids by pressure with an iced sponge. If no marked limitation of rotation in the direction of the contracted muscle is perceptible, some shreds of tendon have escaped, above, below, or farther back between the tendinous substance and the sclera. The wound must then again be explored carefully in these directions, and such filaments, if found, divided. To do this the speculum may be reintroduced, or the eye may be held open by the fingers of an assistant. After this, another test of limitation may be applied. If ether has been used, it will be necessary to wait five or ten minutes till consciousness and self-control are regained. For reasons already given, the immediate effect varies in different cases, but if a limitation of from three to four mm. has not been obtained, it is because the tendon has not been completely separated. As a guide in reaching for the tendon with the blunt hook, it should be remembered that the centre of insertion of the internus is about five and a half mm. from the margin of the cornea, and that the corresponding point of the externus is slightly more distant.

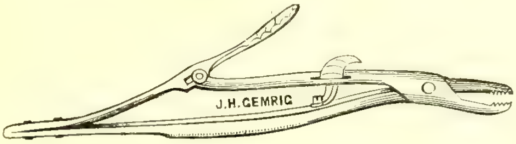
The same steps are to be taken in operating on the external rectus, remembering, however, that a complete tenotomy in this instance does not accomplish as much as in the former case. Tenotomy of the superior and inferior recti is rarely executed, but is done in the same way. The hemorrhage is usually very slight, and the blood is soon absorbed from beneath the conjunctiva. Quick removal of the speculum and pressure with a cold sponge readily check it. The vision of a previously amblyopic eye is sometimes immediately much improved. In a little blonde child, six years old, with excessive convergence, in whose case I practised a double tenotomy, the defective eye, from being able to recognize no letter at fifteen feet, improved so that its vision was 0.2, as soon as tested. But the improvement, if it continues at all afterwards, is then much less rapid.

I must again exhort the surgeon not to be too impatient to accomplish complete correction by the first tenotomy, whether single or double. Wait patiently a few weeks or months, enjoining frequent exercise of the weak muscles, and using atropine, glasses, stereoscope, separate exercise of the amblyopic eye, etc., before risking a second operation. This plan is especially to be employed if the squint be convergent, and the remaining deviation slight. If diplopia occurs, it is an encouraging symptom, and may give way to binocular vision; or it may again subside by suppression.

In testing the effect produced by a tenotomy of the externus, we must be guided by the outer edge of the cornea and the external commissure of the lids. Before a successful operation, the corneal margin can be rotated beyond the commissure, while now it falls short by two or three mm. The correcting effect of division of the externus is much less than that of the same operation on the internus. In either case it is wise to be satisfied with slight insufficiency, and not to make extensive dissections or incisions in the capsule. After tenotomy, especially of the internus, there is some increased prominence of the globe. This is one of the numerous reasons for operating on both eyes, rather than attempting to accomplish the whole correction on one side. The greater or less effect produced by a perfect tenotomy depends more on the activity of the antagonist, and its subsequent shortening, than on the elongation of the divided muscle. Hence, in cases of contraction from paralysis of the antagonist, or from a previous and excessive operation, tenotomy has no effect except to increase the already unsightly exophthalmus. A well-timed and extended *advancement* is the only rational interference in such cases. While tenotomy sets the tendon back, and weakens its effect, advancement sets it forwards and increases its action. Tenotomy produces exophthalmus; advancement helps to diminish it. Tenotomy is always practised on the too much contracted muscle, while advancement is employed for that which is elongated and weakened, on purpose to shorten it and increase its power. Advancement seems a more rational way of restoring equilibrium between muscles than tenotomy. But, owing mainly to the difficulty in its execution, it is not often resorted to, except to correct over-effects or deviation from paralysis. In most, if not in all cases, however, of so-called latent strabismus, or insufficiency, advancement promises more certain relief than tenotomy. Theoretically, the new insertion may not be symmetrical with the original attachment, and may result in diplopia and other binocular inconveniences. But this has not been realized in practice. Whether the advanced tendon has been spread a little more or less, or whether the upper edge has been advanced a little more than the lower, seems not to exercise any serious influence on the future use of the eyes. Even in extreme cases of insufficiency from excessive tenotomy, and in those of rigid contraction from paralysis, it is astonishing how much may be gained by this operation. I have advanced totally inactive muscles left by excessive strabismus operations, twenty years before, with very great improvement in appearance, and with reasonable restoration of motor activity. It seems that complete severance of a tendon from all connection with the globe, even for long years, does not lead to atrophy and uselessness of the muscle. When reunited, in a favorable position, it soon discharges its functions well. My own advancements, and many others which I have seen, have given very gratifying results. Indications for this operation will certainly increase with further experience. The little more time and trouble required for executing a successful advancement, should not weigh against the best interests of the patient and of enlightened surgery.

The operation is performed as follows: The patient having been rendered thoroughly unconscious with ether, and the eye being held open by a speculum, as in strabotomy, the ball is seized by strong fixation forceps near the margin of the cornea, directly opposite the muscle to be advanced. It is then firmly rotated in that direction, so as to expose the region to be dissected. Held thus by an aid, the surgeon seizes a fold of conjunctiva, about two mm. from the corneal margin, and divides it vertically for five or six mm., and with repeated touches separates it from the sclera over the muscular insertion, and farther back. When the tendinous attachment is found, the blunt hook is passed under the tendon, so as to raise it and make it tense. Holding it thus firmly, one blade of a toothed forceps is passed behind and one in front of it, so as to seize and hold it tightly. Then with the scissors, it is detached close to the sclera and held and lifted forwards, so that it may be pierced with the needle from behind forwards. A well-waxed thread eighteen inches or two feet long is sufficient. This is armed with a needle placed in the middle, and with another needle near each end. The main needle, fixed with Sands's holder (Fig. 876), is then passed through the middle of the raised and stretched tendon, from behind, and about four mm. from the forceps. The needle may be passed forwards under the conjunctiva, finally piercing it near the cut edge. The holder removed, the needle is seized and drawn through five or six inches. Then one of the other needles is fixed and carefully passed under the conjunctiva next the cornea, avoiding piercing the sclera, and brought out about three mm. from the centre of the upper margin of the cornea; the thread is drawn through, and the needle is removed. Then the other is secured and passed in the same way below. These needles being removed, and the threads cut off close to the first needle, the surgeon is ready to tie the knots. The tendon is now held by two threads, which are to be tied, one by the operator, and the other by his assistant. They must be gently and evenly tightened, and firmly knotted. Before tying the threads, it is better to remove the speculum. In this way the tendon is drawn firmly forwards and spread out over the denuded sclera. If the antagonist muscle is much contracted, its tendon should be divided, after the threads are placed and before tying them. In this way the effect may be greatly increased. Then the amount of advancement may be intensified by piercing the tendon farther back towards the caruncle, for the internus, and towards the equator for the externus. In very high deviations, a piece of the tendon may be sacrificed before knotting the threads.

Fig. 876.



Sands's needle-holder.

In the extreme cases to which this thread operation has been usually restricted, it is desirable to adopt every means of increasing the effect, and even then a second advancement may be necessary. In one of the worst cases which I have ever seen, produced by tenotomy of the internus twenty years before, a second advancement was made a year after the first, and the result was admirable.

The operation having been completed, the patient should be put quietly to bed, with the eyes bandaged, and cold water dressings should be used for a few hours. The next day the eye may be gently opened, but not allowed to move much, and then closed. At the end of forty-eight hours of quiet, the threads may be carefully removed, but the eyes must be immediately rebandaged, and kept so for several days longer till the adhesions are firm. The success of this very important operation depends largely upon the absolute stillness of the eyes for the first four days. As the method of advancement is more perfected and made easier, its application will become more general. In moderate cases of strabismus, and in all cases of insufficiency requiring surgical treatment, the muscular balance may be restored by advancing the elongated muscle instead of setting back the contracted one. The dangers of muscular insufficiency, sinking of the caruncle, and unsightly exophthalmus, will be thus entirely avoided. The only instruments needed in this operation more than in an ordinary strabotomy, are the three needles. A double hook, as devised by De Wecker, facilitates the operation, but is not indispensable. I recently made a thread advancement of the externus in a young medical student. He first had very troublesome insufficiency of the interni, for the relief of which I employed division of the externi, first of one, and, a few days after, of the other. Relief was only partial, and the externi were divided a second time. Then convergence with distressing diplopia followed. All objects beyond eight inches were doubled, with homonymous images, and anything held nearer than four inches was seen double, with crossed images. I then made a careful advancement of one externus, with complete relief. In such a case again, I would advance the internus in the first place.

There are but few accidents possible after a strabotomy. There may, in rare cases, be profuse hemorrhage, which is easily controlled by cold compresses, and which does not interfere with the result. Very rarely, endocapsulitis with some suppuration occurs. With blunt scissors, used with ordinary care, there is no danger of cutting through the sclera. A few times I have seen pretty severe inflammation, and marginal ulceration of the cornea, follow an advancement, but they were always controllable, and resulted in no damage to sight.

Diseases of the Eyelids.

Blepharitis.—Inflammation of any part of the eyelid is called blepharitis. Having regard to the texture first and chiefly involved, it is called blepharitis ciliaris, blepharitis marginalis, or simply blepharitis. All serious inflammation of the conjunctiva is attended by more or less blepharitis. Erysipelas of the face is apt to invade the lids, as elsewhere described. Abscesses of these parts, their importance and special treatment, have been considered in connection with injuries of the orbit. The worst cases of ectropium follow deep and extensive burns of the lids, or sloughing from erysipelas. A reserved prognosis in such cases is always wise. The common stye is often attended by great pain and alarming swelling, but is easily diagnosed by a point of greatest tenderness to pressure. It discharges spontaneously or by puncture, like a furuncle, and soon recovers. A succession of styes and boils indicates bad assimilation, and is best treated by constitutional tonics. If a costive habit be present, it must be relieved by laxatives. Locally, continued warm poulticing is all that is required. Syphilitic and cancroid ulcerations of the eyelids are always alarming. They readily lead to destruction of tissue, exposure of the eye, ectropium, painful loss of sight, and even loss of life. Epithelioma and other destructive processes in the upper lid are vastly more disastrous than in the lower. While the entire lower lid may be destroyed, or removed by operation, without serious deformity or danger to the integrity of the eye, a very small defect in the upper lid both excites remark and becomes grave in its consequences. Epithelioma of the eyelids requires prompt and radical operative treatment. It is in these cases especially, that the melancholy effects of the caustic applications, so much in vogue among mercenary quacks, are witnessed. As soon as a syphilitic sore is detected on the eyelids, antisyphilitic treatment must be heroically adopted, and no operation resorted to, except perhaps at a later period, for plastic purposes.

The most common form of inflammation is that which is limited to the free edges of the lids, and is called *blepharitis marginalis*, or *ciliaris*. It is confined mainly to scrofulous children, seldom occurring for the first time in adults, except as a complication of dacryocystitis. The exclusive victims of this disease, strumous children, are likely to have also phlyctenular keratitis, with eczematous eruptions on the face and scalp, behind the ears, and in and around the nose, and enlargement of the glands of the neck. The children of indigent and dissipated parents of dirty habits, are the most frequent sufferers, and their successful treatment is almost impossible.

The *diagnosis* of this disease is very simple. The redness and swelling of the margins of the lids are not striking, and often very partial. But more or less scabbing in the region of the eyelashes is a constant phenomenon. Suppuration in the individual hair follicles, and the formation of crusts by drying, that unite the lashes in tufts and sometimes accumulate for months, becoming large and almost horny, are the characteristic symptoms. These scabs adhere very closely, and are hard to remove. When they are fully detached, the lid bleeds from ulceration of the skin, a process that may be limited to a few cilia, or may extend the entire length of the lid. The scabbing, burrowing of pus, and destruction of the hair bulbs, continue for years, till the patient is at last deprived of eyelashes, seriously disfigured, and annoyed for life.

Treatment.—Absolute cleanliness must be enforced. The lids are to be bathed with warm water, for half an hour or longer, twice a day. When the scabs are thus softened, they must be thoroughly removed by rubbing with a soft rag over the end of the finger. This failing, they must be detached by a small spatula, or with cilia forceps, no matter at what cost of screaming and bleeding. Firmness on the part of the surgeon is demanded, as the nurse is always timid and fails to do the work fully. The child must be held across the nurse's lap, face upwards, and the head firmly clasped by the surgeon's knees. He is thus master of the situation if he have already mastered the mother or nurse. When every trace of the scabs has been removed, it greatly expedites the cure to trim the lashes as closely as possible with a small pair of scissors, and to repeat this at least once a week. The raw surfaces, thus exposed and dried, are now to be touched quickly and lightly with a pointed stick of nitrate of silver. A solution of from ten to twenty grains may be used in preference, applied carefully with a small brush, and limited strictly to the ulcerated portion. Great care must be exercised to prevent its flowing into the eye. When the surface is slightly whitened, the free use of water will remove the surplus. This may be repeated once or twice a week, as long as there is any manifest ulceration. In the evening, before bedtime, warm ablutions, cleansing, and drying, must be followed by the use of some one of the mercurial salves, rubbed along the roots of the lashes and left till morning. These should be weak, non-irritating, and in small quantity, but well rubbed in with the finger. Calomel, with vaseline or lard, gr. j to ʒj, or red precipitate, gr. ss to ʒj, pure and thoroughly incorporated by rubbing, are excellent remedies. The yellow oxide of mercury in the same strength may also be applied, but I find that it often causes too much irritation. For many years I have used the diluted, brown citrine ointment with almost constant success. On the lids I use ʒj of the ointment, rubbed up with ʒiij of lard. For the nose, ears, scalp, lips, etc., it may be applied in full strength. After thorough washing with soap and warm water, to remove all the dry scabs, the raw surface should be brushed with the solution of silver nitrate, and afterwards well greased with the salve. This is best done at night, and the eyelids may be treated in the same way.[1] If, after a fair trial, one of these salves fails, another may be tried. After a few days of such treatment, the scabs will cease to form, and the force of the malady will be greatly lessened. But the use of the salve must be kept up for months, at longer intervals, in order to prevent a return of the diseased process.

At first the lids must be freed and greased every night. Then every second night, afterwards twice a week, and, finally, at least one application of the salve every week must be continued for months after the lids seem well. Till the cure is well advanced, the surgeon himself should conduct the treatment, even applying the salve in the day himself, if he cannot be sure of its proper use at night. Combined with these necessary, local measures, the long-continued use of iron, iodine, and cod-liver oil, inwardly, must be enforced. A favorite remedy with me, is the syrup of iodide of iron, long continued. As a dose after each meal, I give as many drops as the child is years old. Bathing the child at least twice a week, at bedtime, in tepid water, followed by lively friction ; good nutritious food at regular intervals ; healthy hygienic surroundings ; and free, daily exercise in the open air, with proper attention to clothing and cleanliness, must be enforced as a religious duty. I cannot too strongly emphasize the necessity for long perseverance in invigorating general treatment, in this class of patients. Present relief and improved health for life, will be thus gained. Unsightly loss of the eyelashes, blear-eyes, trichiasis, ectropium, weeping, and a train of other torments, are prevented by proper, early treatment. The management of phlyctenular keratitis, and of the skin-diseases so often associated with blepharitis ciliaris, has been described under another head. I wish only to call special attention here to the prompt relief afforded by the mechanical removal of the thickened epithelium at the seat of the phlyctenula, and along the bands of vessels leading to it, in the so-called "band keratitis." I am constantly in the habit of using a wooden tooth-pick, and prefer it to the spud or probe. The tooth-pick must be hard, tough, and sufficiently stiff. The small end is dipped in pure carbolic acid, and then ploughed along the course of the vessels and the seat of the phlyctenula, so as to scratch off the half-dead tissues. This must be done thoroughly, holding the lids firmly apart with the thumb and finger, without eversion. The bloodvessels are thus scraped off with the other new products, and the free bleeding is decidedly beneficial. The point of the tooth-pick can now and then be dipped in the acid, so as to whiten and destroy the diseased tissues. Water can be held ready, and put on if too much acid is present. The wood absorbs and holds the solution better than a metal instrument. After this is thoroughly done, a drop or two of atropine solution relieves the pain. It is wonderful how quickly the violent symptoms are thus controlled.

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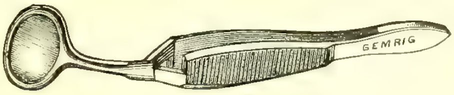
[1] The citrine ointment may be made according to the following formula: ℞.—Hydrargyri, ℥jss; Acid. nitrici, ℥iijss; Olei morrhuæ, ℥xvjss. Dissolve the mercury in the acid; then heat the oil in an earthen vessel, and, when the temperature reaches 200° F., remove it from the fire. To this add the mercurial solution, and, with a wooden spatula, stir constantly as long as effervescence continues, and afterwards occasionally until the ointment stiffens.

CHALAZION.—Inflammation with obstruction of the excretory ducts of the Meibomian glands of the lids, is a rather common trouble. Some swelling, like that of a stye, soreness, and pain, are present, and in a short time a yellow point indicates a collection of pus and of the proper secretion of the follicle. Warm fomentations at first, and puncture when the ripe stage appears, are the successful remedies. In adults, tumors of the lids often develop with little or no inflammation, projecting under the skin and giving the feeling to the finger of a hard shot or bullet. These are sometimes single, but oftener multiple, and a succession of them is frequently noticed. They are situated over the region of the tarsus of the upper or lower lid, and sometimes reach the size of a hazel-nut, mechanically impeding the free movements of the lids. They are situated in the thickness of the tarsal cartilage, and are composed of a cyst, filled with a tough, gelatinous substance. Now and then, with more acute inflammation, the contents are somewhat purulent. This tumor is generally called *chalazion*, and requires surgical treatment. One method is to evert the lid, find the thinned point, and puncture through the conjunctiva. The incision is usually made perpendicularly to the free edge of the lid, and the contents are scooped out. If the cyst be rudely torn in this process, in various directions, complete obliteration from adhesive inflammation will be more certainly secured. If the everted lid be firmly squeezed between the thumb and finger-nail, the contents and cyst wall will be more surely forced out. If this be thoroughly done, no cauterization of the sac will be needed.

Where the cyst-wall is thick and hard, and the growth presents itself conspicuously under the skin, I much prefer enucleation. This is done through the skin, and with the aid of the ring forceps (Fig. 877), to avoid bleeding. When the blades have been firmly closed by tightening the screw, and the tumor has been made to project sharply through the ring, the skin is incised over the whole length of the growth, longitudinally. A few drops of blood escape on cutting through the skin, but, this being sponged away, no further trouble from hemorrhage is experienced. The cyst is now exposed, and with a few snips of scissors carefully detached from the other tissues, excepting underneath. An assistant then draws the skin aside with forceps, when the cyst is seized, raised from its bed, and detached from the parts below. Care should always be taken to remove as little of the surrounding structures of the lid as possible, and to avoid cutting a hole through the conjunctiva. A small opening in the conjunctiva does no harm, but it should be left entire, if possible. When the cyst and its contents are removed, the wound is closed with one or at most two stitches in the skin. It heals by first intention, and all traces are gone in a few days. This little operation, when neatly done, is very satisfactory; but when awkwardly executed, insufficiency of the lid, notching of its margin, and sad deformity may result. There is no use in cauterizing these tumors, or rubbing them with salves, or taking constitutional remedies to remove them. Such measures do not succeed, worry the patient, and must yield at last to proper surgical treatment. Tonics, especially iron and bitter remedies, may be useful in promoting a better assimilation, and preventing the occurrence of new growths.

Fig. 877.



Ring-forceps for tumors of eyelid.

Sebaceous tumors, either congenital or acquired, sometimes form under the skin, about the edge of the orbit. They may reach a large size, and sometimes contain hairs. Where such a growth presses upon the bone, it develops a pit, and is usually firmly adherent to the periosteum, making complete removal difficult. Rules for the direction of incisions for their removal, and other precautions, have already been given. They usually bleed freely, and, when the cyst is cut, as it is apt to be, the operation may become very troublesome. If any portion of the sac is left, the tumor is sure to be reproduced. After adequate stitching, a compress is put over the pit that is left behind, and a roller is applied to prevent hemorrhage and subsequent suppuration.

Lagophthalmus.—The name *lagophthalmus*, or *hare's-eye*, is based on a romantic notion that the timid animal after which it is called sleeps with its eyes open. Lagophthalmus is generally due to paralysis of the facial nerve and the muscles which it supplies, but sometimes results from cicatrices of various kinds and degrees, and rarely from congenital defects. Great distress and serious danger to the integrity of the eye always result from paralysis of the orbicularis muscle. Constant weeping during wakeful hours, and dryness from exposure in sleep, keep the eye always irritable, and ready to take on destructive inflammation. The necessity for the constant, healthy action of the sphincter of the eyelids and of Horner's muscle, shows itself in defective function of the sewer system of the eye. *Epiphora*, or overflow of tears, is the first symptom of this great trouble, and persists as long as any deficiency of muscular activity continues. Whether facial paralysis be due to peripheric or central causes, or to disease of the drum of the ear, it may never disappear, in which event surgical relief is the only hope. The lids, in every case, should, during sleep, be kept closed by a compress and bandage, to prevent the evils of exposure. Even by day, an hour's rest with the eye thus closed by a wet compress, affords great comfort and protection. When inflammation and ulceration of the cornea set in, constant protection by closing the lids must be enforced. More permanent comfort may be secured by a plastic operation on the lids. This is done by paring the free edges of the upper and lower lids, near the outer commissure, and uniting them by stitches or twisted sutures. By leaving the outer angle itself free, the union can be afterwards severed, in case the paralysis disappears. The edges should be made raw for from a fourth to half an inch, according to the amount of insufficiency. Nothing need be cut away but the skin covering the free margins, avoiding the Meibomian follicles and the eyelashes. The union thus secured, relieves the patient's distress, and greatly improves his personal appearance. In confirmed cases, resulting from disease of the ear, I pare the two lids half-way between the centre and the outer commissure, for a short distance, and secure permanent union with very great improvement. The lids are excessively relaxed, and the patients, before the operation, cannot work for constant weeping. I have done this and seen it done many times, and always with benefit. Following the advice of Von Graefe, I have several times practised a similar canthoplasty in extreme cases of exophthalmic goitre. In some, relief and improvement have been gained; but in others the destructive inflammation of the cornea has seemed to be hastened. In facial paralysis the operation is always beneficial.

Ptosis.—Ptosis is a drooping of the upper lid from paralysis of the levator palpebræ muscle, or from congenital absence of the muscle. As the other branches supplied by the third nerve are usually implicated, we see at the same time divergence of the eye and inability to move it in any direction but outwards. The pupil is also dilated, and the accommodation paralyzed. When the lid is raised, of course there is harassing diplopia. Hence the ptosis should not be corrected till the divergence and double vision have disappeared. If it then still persist, it may be safely remedied by an operation. Unsightly drooping, and a sleepy expression of one or both upper lids, generally accompany bad, chronic cases of granular conjunctivitis. Should this drooping persist as a serious deformity, after treatment has relieved the disease, it may be corrected by a well-timed operation. Of the methods recommended, I usually prefer the removal of a horizontal fold of skin. The strip removed should extend the whole length of the lid, and should be of the same width throughout, at most not exceeding five millimetres. In all operations on the lids, where skin is sacrificed, it is far better to get too little than too much effect. The excision should not come nearer than four mm. to the free margin. We seek to raise the whole lid equally, and naturally, and not to change the normal position of the cilia. For a beginner, it is safer to dot out with ink the piece to be removed, and to confine himself strictly to that. Careless use of the forceps and scissors, is very apt to lead to disastrous excess and insufficiency of the lid. Too much caution in this respect cannot be enjoined. The wound is closed with a good number of very fine sutures. The elevating effect may be increased by passing the needle first through the lower edge of the skin, and then re-entering it, going deep enough to graze the tarsus, and coming out through the upper edge. The stitches can be removed in twenty-four hours. The swelling and increased weight of the lid make it droop almost as much as before, and the final effect is not seen until a later period. If necessary, another careful operation may be repeated a few months after.

Other methods are practised and may sometimes do better, such as the use of loops of subcutaneous ligature, recently recommended by Pagenstecher. If loops of sutures, passed under the skin near the free edge, brought out above, and tied, will accomplish the same elevation, there will be less danger of insufficiency, unless the threads are drawn too tight and left too long. In case unsightly folds remain behind, the surplus may afterwards be removed. I have lately had under care a case of congenital drooping of both lids, to such a degree that the patient, a young man, walked with his head painfully drawn back, and chest projecting. Folds were removed and the sutures passed deeply near the upper edges of the tarsi. The result was excellent.

ENTROPIUM AND TRICHIASIS.—A frequent sequel of granular lids, is incurvation or troughing of the tarsal cartilage. This leads to inward displacement of the eyelashes, and trichiasis. In the cicatrizing process of trachoma, the tarsal conjunctiva contracts, atrophies, loses its polish and secreting capacity, and distorts the tarsus horizontally by drawing its two edges towards each other. Rude friction, by the stiffened lid and eyelashes, on the cornea, gives rise to unmanageable keratitis and pannus. Tenderness to light, dimness of vision, frequent attacks of painful ulceration of the cornea, weeping, and endless trouble, are the results. The shrinking process of atrophy leads also to obliteration of the reflected folds, and to much limitation in the movements of the eyes. Moreover, the lids are slowly united at the outer commissure, and troublesome phimosis results, greatly aggravating the trichiasis. Such lesions are permanent, and can only be benefited by surgical treatment. Of the many devices practised for the relief of trichiasis and its consequences, the most unsatisfactory is the mere excision of a horizontal fold of skin. It leads to insufficient closure of the lids, without materially correcting the malposition of the lashes and deformity of the tarsus. Better results are obtained by splitting the lid between the tarsus and the bulbs of the eyelashes, excising a fold of integument, and then stitching so as to slide the lashes with their bulbs up on the anterior surface of the tarsus. Various modifications of this procedure may be practised, but they all leave the main difficulty untouched, in trichiasis from incurvation. The *malformation of the tarsus*, if it exists, is the first and most important thing to be corrected. This is done in different ways. An incision through the skin, and from three to four millimetres from the free margin of the lid, extending the whole length of the tarsus, is first made. To avoid bleeding and greatly facilitate the operation, the ring forceps should be used. The skin being incised to the full length required, and the fibres of the orbicular muscle separated, the white, firm tarsus is properly exposed. Then, seizing it with stout, toothed forceps, and lifting it up, a Graefe's knife is used to take out a wedge-shaped piece, cutting from without inwards, from the whole length of the thickened tarsus. Great care is taken to avoid cutting through and sacrificing any of the conjunctiva. This done, the edges of the skin are carefully united by four or five fine sutures. Instead of trying to remove the whole piece at once, it is better to seize the tarsus at different points, and remove a portion each time, till the end is accomplished. The knife may be made to cut down on one side and out on the other, gradually rotating it as it approaches the conjunctiva. Thus a succession of central, horizontal excisions are made.

There is more danger of not removing enough, than of removing too much of the stiff tarsus. If one or more small holes are made in the conjunctiva, they do no serious harm, but it is best to save that membrane entire if possible. A very narrow strip of skin is to be removed, either before the tarsus is excised, or after. It should not exceed two or three mm. in width, and this should be equal throughout its length, excepting at each end where the incision runs to a point. The quantity of skin removed should depend on the surplus present, but it is often very disastrous and unnecessary to remove much. If marked phimosis is present, a canthoplasty at the outer angle is to be made at the same time. A great change in the position of the lids may be secured in this way. If the incurvation and trichiasis are slight, a canthoplasty alone may be sufficient to relieve the inversion. In all cases of troughing of the tarsus, and especially where very little if any skin can be spared, I have been much pleased with the operation of Dr. Green, of St. Louis. He everts the upper lid, holds it firmly, and cuts through the conjunctiva and the tarsus in the whole length of the latter. He keeps the incision two mm. from the line of orifices of the Meibomian ducts, and uses a scalpel. A Graefe's knife, held perpendicularly to the tarsus, plunged through, and pushed along carefully, does equally well. If desired, the incision can be prolonged at either end with stout scissors. The ring forceps are not necessary. The effect produced by this incision is to separate the entire margin of the lid from the body of the tarsus, and thus to allow it to be easily everted, and to be held without strain in its new position. A strip of skin from one and a half to two mm. in width, is excised, its lower boundary being about one and a half mm. from the line of eyelashes. The sutures are applied with a curved needle in the usual holder. The needle is entered through the conjunctiva, a little within the rows of lashes, and brought out through the wound of the skin, close to its lower edge. Drawn through far enough, it is again passed under the upper lip of the incision, deep enough to graze the tarsus, and to come out through the skin about ten mm. above the point of entrance. When the suture is knotted, the cutaneous wound is closed, and the loosened margin of the lid is at the same time everted and brought into proper position. Three sutures are usually enough, and they should be removed in twenty-four hours. Healing is prompt, and the gaping tarsus on the conjunctival side heals by granulation, leaving no rigid cicatrix. Very little integument need be sacrificed.

I have seldom resorted to this operation before the trachomatous cicatrization has been completed, but it may be done during the active progress of the disease, to hasten recovery. If necessary, it may be repeated. Where large losses of skin from other previous operations forbid further sacrifice, a simple incision in the skin, and some loosening of the upper lip of the wound, with careful placing of sutures, will suffice. In extreme cases of phimosis, canthoplasty may be combined with this operation. If the tarsus is much hypertrophied, hard, and prominent under the skin, I remove a longitudinal, wedge-shaped portion through an incision of the skin, as above described. With one or the other of these operations, all cases of entropium, incurvation, trichiasis, and distichiasis, can be relieved. The orbicular fibres are preserved in both, and the circulation of the lid margin is not at all seriously impaired.

If the free ends of the eyelashes, from any cause, touch the cornea, they are popularly called *wild hairs*, and must be removed by surgical interference. If they stand free, however, they are harmless ornaments, and should be respected. Spasmodic entropium, occurring usually in old people with relaxed integument, is a serious trouble, and must be obviated. This tendency is increased by bandaging the eyes, as after cataract extractions and other operations. The reflex influence of the displaced lid prompts to still greater contraction and firmer inversion. The annoyance is extreme, and greatly increases the risks of such operations on the eyeball. If possible, the roller should be removed in all such cases, and the eyes kept open. By holding the lower lid down, and keeping the eye open, the inversion is easily overcome. Collodion applied to the skin, and allowed to dry, will often suffice to keep the lid in place, till the spasm ceases. Various surgical operations, combined with excisions of skin from the lower lid, are practised for its permanent relief. In all operations for entropium, where a sacrifice of skin is thought advisable, great care must be taken to avoid excess. It is always easy to remove a little more integument, at another time, if needed. In people of advanced years with great relaxation and excess of skin folds, a freer excision may be risked. An actual ectropium, or imperfect closure of the lids, or both, after an operation for inversion, is always to be guarded against. Prudent foresight, here as everywhere else, may save the patient's temper and the surgeon's remorse.

Canthoplasty.—The operation of canthoplasty is practised for opposite purposes in different cases. In one it is done to enlarge the too small commissure; in the other to secure its diminution. The latter operation has already been described. The first step in securing increased space is to divide the outer angle with stout scissors or a bistoury. Profuse hemorrhage, in this operation, cannot be avoided, and is a great hindrance. The incision must be in the direct line of the canthus, and should usually extend to the bony orbit. Firm pressure with a sponge will, in a few minutes, control the bleeding, so that the other steps may be executed. The divided corner should be forced widely open by an assistant, everting it as much as possible. The conjunctiva is then seized by the forceps, gently raised, and loosened from its connections with the points of the scissors. This causes it to slide easily, and to cover the raw edges better. Then the conjunctiva and skin are to be stitched together. The first suture is applied exactly in the angle. Two others usually suffice, one above and the other below. Great care must be taken to secure perfect coaptation. Thus the raw edges are kept from readhering. Cold dressings are applied, and in about thirty-six or forty-eight hours the threads may be removed very cautiously. The proper execution of this bloody operation secures freer eversion of the lids, and valuable space. It may often be combined with an entropium operation, and the degree of freedom secured may be regulated by the extent of the incision.

Ectropium.—Ectropium is an eversion of the eyelid, preventing perfect coaptation. It is seen in various degrees, due to various causes. The most serious and frightful cases are those resulting from deep and extensive burns of the face. Scars from wounds of the lids and adjacent parts, from ulceration in skin-diseases, from abscesses and sloughing during facial erysipelas, and from caries of the bony orbit, are all very likely to be followed by this deformity. Chronic blepharitis, with loss of eyelashes and contraction of the skin, from chafing caused by eversion of the puncta and constant weeping, is a common source of troublesome eversion. Then the chronic forms of conjunctivitis with swelling and hypertrophy, lead to constantly increasing ectropium. As the edges of the lids become thickened and relaxed, with the marginal fibres of the orbicularis muscle, the bundles over the orbital edges of the tarsi contract spasmodically, and intensify the displacement. Abscess of the orbit with protrusion of the eye, and extreme exophthalmus in Basedow's disease, are sure to be complicated by inflammatory ectropium. This trouble is much more frequent in the lower than the upper lid, but not so disastrous to the eye. The weeping from displacement of the punctum, especially the lower one, the constant exposure of the everted mucous membrane to irritating causes, and the want of protection to the eyeball, all contribute to increase the deformity and its dangers. In facial paralysis, the swagging of the lower lid sometimes results in total eversion and great annoyance. The paralysis of the fibres of the orbicularis of the lower lid, and the relaxed condition of the same in old people with chronic conjunctivitis, are important factors in the production of this disease.

The *treatment* of ectropium is palliative, and if possible curative. The first point to be made out, with a view to treatment, is the etiology. If cicatricial contraction of the skin is the cause, that must be relieved in a way best adapted to each case. General rules only can be given: the special modifications must be suggested by the genius of the surgeon. Extensive dissections, torsion and sliding of flaps, and especially great tension after the use of sutures of whatever kind, are very liable to result in failure to heal by first intention, sloughing, and serious aggravation of the original deformity. It is for this reason that skin-grafting and transplantation, after removal of scars and proper preparation, have of late years been so extensively tested. There is no other region of the body where a skilful resort to this safe process is crowned with such brilliant results. If the patient is not completely relieved, he is probably somewhat benefited, with a chance of further improvement in the future. At all events, the case is not made worse by the operation. The great advantage of skin-grafting is that it can be properly employed in the early cicatrizing stages, to prevent as well as to relieve; while plastic operations by sliding, etc., must be deferred a very long time, to diminish the risks of sloughing. In *ectropium paralyticum*, canthoplasty, as already described, is always applicable, safe, and beneficial. As a rule, entropium following trachoma with contraction, or chronic marginal blepharitis, is aggravated by blepharophimosis. To overcome this by dividing the external commissure, and stitching the skin and conjunctiva so as to prevent closure, thus enlarging the palpebral opening, helps very much to relieve the inversion. On the contrary, in treating ectropium, the outer commissure should be pared and united in many cases, as one of the means of affording relief to the deformity.

In some cases, with great thickening of the everted conjunctiva and hypertrophy of the tarsus, an excision of a longitudinal portion of the diseased structures, the wound being closed by loops brought out through the skin below and tied over a small tent, gives excellent results. The wise choice, in each case, of the best method or combination of methods, to suit the peculiarities present, will distinguish the surgeon of tact and experience from the mere cutter. Of all the regions of the body, the face divine calls for the most thoughtful and skilful surgery. A bad job, anywhere else, may be covered up, and in a measure concealed from the gaze of the curious and the critical; but a marred visage is an open reproach to the surgeon, and a source of extreme mortification to the patient.

The treatment of the ectropium which results from deep burns of the face, from caries of the orbit or injuries with depressed cicatrices adherent to the bone, and from mutilations of various kinds, is a department of plastic surgery too important to be dealt with briefly. For the various methods by which these conditions are to be ameliorated, I can only refer the reader to more elaborate works on ophthalmic surgery. Suffice it to say that, with few exceptions, the results are uncertain, and failures often disastrous. In my opinion, efforts to effect a cure by skin-grafting, combined with careful plastic operations, give the most promise for the future. Merely cosmetic surgery, if not brilliantly successful, is not appreciated; and *failures* may likewise be *brilliant!*

SYMBLEPHARON.—To avoid nice distinctions and long names, I include under this head all unnatural adhesions of the lids with one another and with the globe of the eye. To allow the utmost freedom of rotation and easy movement of the lids, a well-lubricated surface and exuberant folds are supplied by the conjunctiva. If the conjunctiva is reduced in its superficial extent by any cause, as by the shrinking process that follows granular lids, two results follow. One is cupping or incurvation of the tarsus; and the other obliteration of the retro-bulbar folds. The former produces more or less rigidity of the lid, and trichiasis; the latter limits freedom of movement. In extreme cases, the degenerated conjunctiva seems to pass directly from the posterior edge of the tarsus to the sclera. This condition is called *posterior symblepharon*, and is incurable. Its evils are enhanced by the dryness of the atrophied conjunctiva, which when extreme is called *xerosis.* In this hopeless degree, the mucous membrane becomes as dry and harsh as the skin. It is the occurrence of this form of symblepharon that deters surgeons from sacrificing a zone of sclerotic conjunctiva in the operation of syndectomy. The directions for that operation are, to incise the conjunctiva entirely around the cornea, dissect it back, and remove a broad band, reaching almost or quite to the equator of the globe. Then the sub-conjunctival tissues are cut or scraped away, baring the sclera completely. This denuded surface is allowed to heal, and, in doing so, it contracts and obliterates the persistent vessels that traverse the cornea and keep up the opacity. The area of the conjunctiva, already much reduced in these cases, is still further diminished. For this and other reasons, I greatly prefer inoculation in extreme cases of pannus, as already stated. The use of jequirity, if equally efficient, would be still preferable to inoculation, because freer from danger. The surface shrinkage of the conjunctiva and the arrest of its secretion are often increased by too severe cauterization in the treatment of granular lids.

Another form of symblepharon is the result of destruction of large portions of conjunctiva by burns or other causes. If the palpebral and ocular conjunctiva are both destroyed, the raw surfaces in contact are sure to unite rigidly. In case the cornea has been destroyed, or severely cauterized, the lids may unite firmly with the entire front half of the ball.

The difficulties in treating this form of adhesion are much increased, if the conjunctiva is destroyed to the bottom of the cul de sac. In that case, it is impossible to pass a probe underneath and around the adhesion, and almost impossible to prevent reunion of the surfaces when artificially separated. The burn often destroys the lid margin, the puncta, and the canaliculi, thus still further complicating the symblepharon. Then again, a hopelessly blind eye, when thus adherent and restrained in its movements, is often painful and detrimental to its fellow. In that case it should be enucleated. A limited symblepharon, especially when a probe can be passed around it, can be carefully detached and kept from reuniting. It is always wise to cover the denuded eyeball, after free detachment, by separating and sliding in folds of conjunctiva from opposite sides, uniting them by fine sutures. Some benefit, and often very satisfactory results, are thus obtained by the skilful adaptation of means to ends.

Erectile Tumors of the Eyelids.—Vascular tumors of different kinds, usually called erectile, often form in or under the skin of the eyelids and face. They are of serious importance, and, when far advanced, always difficult to cure without deformity. Timely surgical interference is always desirable. Whether congenital or not, these unsightly diseases are very apt to increase, if not promptly treated. In some that are well defined and subcutaneous, a careful enucleation is practicable. If cut into, however, alarming hemorrhage is sure to follow. Some form of ligature, either subcutaneous, or, in bad cases, even including the skin, will usually suffice. Acupuncture, and even the galvano-cautery, are often indicated. Coagulating injections are very risky, and I have seldom used them. There is no class of diseases which requires, at the same time, more surgical thoroughness and prudence. If the growth originates in, or invades, the conjunctiva, the difficulties and dangers are greatly increased. In the case of a young lady with such a tumor of the conjunctiva scleroticæ, I resorted to subconjunctival ligation and subsequent excision, but the growth again increased. Dr. S. C. Ayres thereupon incised the conjunctiva and dissected it from the tumor, which was then firmly ligated close to the sclera and cut away in front of the ligature. Afterwards a small nodule of vessels remained, which was raised with forceps and snipped away. The recovery was complete. This case is illustrated in Plate XXVII., Fig. 1.

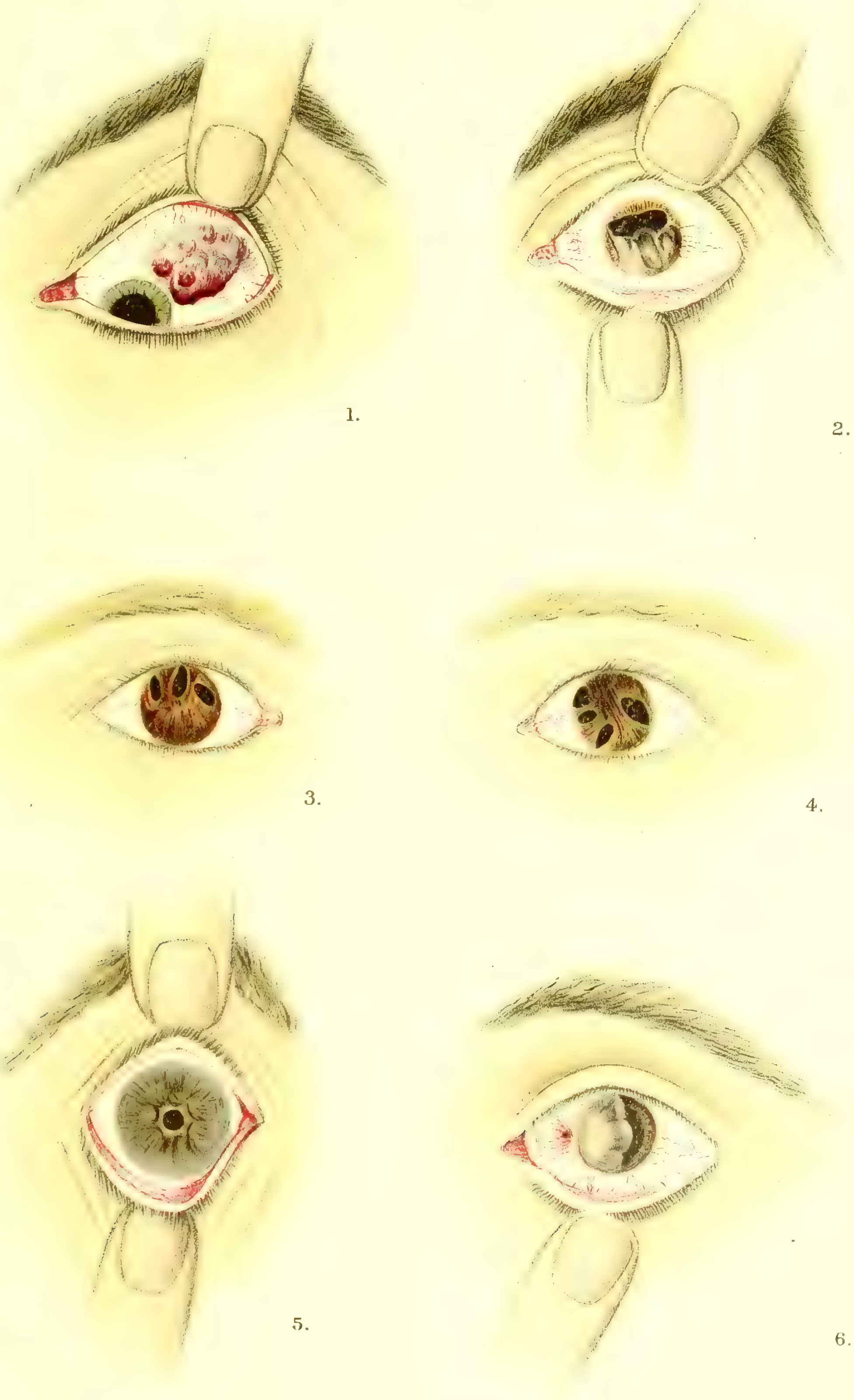
Diseases of the Tear Passages.

The necessary drainage of the eyes is secured by a system of sewers, composed of the tear sac, nasal duct, and canaliculi. At the inner end of each tarsus is seen a small round opening, the *punctum lachrymale*, which is the beginning of the canaliculus leading to the sac. The lower punctum, by its position, seems to be more important than the upper. In health, the mechanism of the process of taking up and carrying away the tears is explained by the action of the orbicularis muscle, helping the siphon system supplied by the canaliculi. Each punctum rests gently against the globe, where it readily takes up the fluid.

Epiphora.—Paresis or paralysis of the circular muscle of the lids, is always attended by a watery eye. This is particularly troublesome in facial paralysis, from whatever cause, and persists as long as the impaired muscular activity. But the healthy action of this muscle can only take away the tears through the puncta when in proper position. Mechanical displacement of these points will lead to constant weeping. Epiphora from this cause alone is often seen in inflammation of the conjunctiva and lids, causing swelling and eversion of the punctum. The same result is produced by contraction of the skin, the presence of lid tumors, hypertrophy of the lachrymal caruncle, chronic blepharitis marginalis, or any other disease that leads to displacement of the punctum. It is often seen in the lax lids of old people, and is explained in the same mechanical way. Some eversion of the lower punctum and troublesome weeping, are constant accompaniments of granular lids. If possible, this annoyance should be relieved by removing the cause. But the constant standing of tears in the eye often aggravates and keeps up the mechanical cause. Hence relief of the epiphora, itself a great boon, may be a means of curing the disease that causes and keeps it up.

Any displacement of the lower punctum is exaggerated when the eye is turned upward. In protracted epiphora from this simple cause, the little opening may be closed up, covered with dry epidermis, and very difficult to detect at all. A faint depression in the dry lid, where it is known that it should be, is its only indication. A small conical probe, gently pressed into it perpendicularly, thence passes on into the sac. When the diagnosis is positive, a very simple surgical operation gives immediate and great relief. I mean slitting the lower canaliculus. The punctum must first be stretched by a conical probe, so as to admit the knife or scissors. A sharp, probe-pointed Weber's knife (Fig 878), or a delicate pair of scissors with a probe-branch, may be used. The latter instrument causes the least pain, and is quickest in its action. The probe-branch is passed into the punctum, and horizontally along the canal, for three or four mm. The scissors are then quickly closed, and the operation is completed. Twice a day for two days, a blunt probe should be

PLATE XXVII.



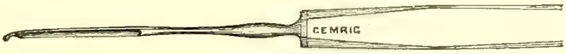
1. 2. 3. 4. 5. 6.

Morbid Conditions of the Eye.

H. BENCKE, LITH. N.Y.

passed along the slit-up canal, till the edges cease to adhere. By this means the punctum is transferred to a point where the tears can reach it. In very rare cases, troublesome weeping seems due to a hypersecretion of tears alone. In spite of the regular action of the ducts, the eye overflows as a stream in a freshet. But the most frequent cause of persistent weeping, is inflammation and obstruction of the lachrymal passages. The force of the inflammation seems to centre in the sac, but the stricture is located in the nasal duct. This condition usually comes on very slowly. Months and even years pass before it reaches a climax. The weeping sometimes disappears in summer, to reappear the following winter, and is always worse out-doors, and in windy, cold weather. At last it becomes constant, the region of the tear sac begins to bulge, and pressure over the sac causes a reflux of mucus or pus through the puncta. With this history, and these developments, the diagnosis of chronic dacryocystitis is established. By slow degrees the lachrymal tumor increases. Some time or other, pressure will fail to empty the collection, and the patient will have acute inflammation and abscess of the tear sac, and, these attacks following at variable intervals, fistula lachrymalis will finally be the result.

Fig. 878.



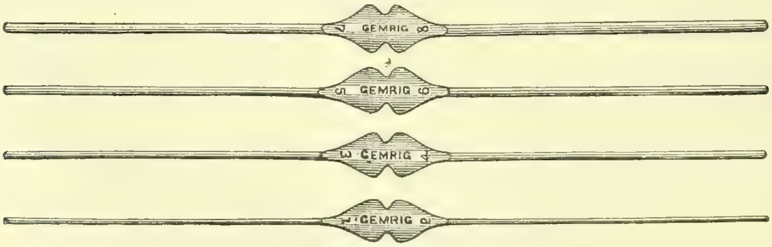
Weber's probe-knife.

Dacryocystitis and Lachrymal Fistula.—Acute inflammation of the sac, abscess, and fistula, are rarely seen, except when preceded by the above symptoms. When the seat and anatomical relations of the tear sac are kept in view, the diagnosis is easy. The tendon of the orbicularis passes across the anterior wall of the sac, and is always raised by the tumor. Pressure over the known region of the sac will generally empty it, forcing the contents through the nasal duct, or back upon the eye. In acute suppurative inflammation of the sac, the point tender to pressure is limited to that region. The seat of greatest swelling and tenderness, the previous history of weeping and other functional troubles, will make it impossible to confound the disease with facial erysipelas, a furuncle over the sac, or anything else. Lachrymal fistula is always *below* the tendon, and near the orbital margin. The presence of a fistula *above* this tendon, anywhere over the upper and inner margin of the orbit, creates at once the suspicion of disease of the frontal sinus. Several such cases have been referred to me as examples of lachrymal fistula. Of course, periostitis, or disease of the os unguis and other bones forming the lachrymal groove and nasal duct, might be confounded with the malady under consideration. But the peculiar history and complications in each case, will clear up the differential diagnosis. I have seen two cases of cyst in the ethmoid bone, resembling lachrymal tumor. Scrofulous subjects, and especially those with persistent ozæna, are the most constant victims of obstruction in the tear passages. In all persons afflicted by chronic inflammation of the nasal mucous membrane, tear-sac difficulties are liable to occur. Rarely, conjunctivitis, acute or chronic, seems to follow the canaliculi into the sac, causing granulations and obstruction. Further than the fact that these local and constitutional peculiarities predispose to this class of diseases, we know but little of their etiology. We very seldom see them in sound people, with healthy mucous membranes. Troubles of the tear sac rarely recover spontaneously, and, when they do, it is after an acute abscess. The *treatment* may be palliative or curative. Gentle pressure, twice a day or oftener, to keep the distended sac free from accumulations, and the use of mild, local astringents, with care in avoiding exposure, constitute the measures which may be employed for palliation. A surer way to stave off acute abscess is to slit the upper canaliculus quite down to the sac, so as to give free and easy vent to the irritating secretions. This allows also of more thorough cleansing of the diseased sac by syringing. These measures, however, only help in keeping matters from growing worse.

The radical and complete cure of dacryocystitis and its consequences, is seldom accomplished, but great relief and comfort, often quite satisfactory to the patient, can nearly always be expected. The first and essential step in the curative treatment, is surgical. Free access to the sac must be had, to allow of the necessary treatment of the diseased mucous lining and of the stricture. There lingers still, in the popular mind, an impression that a precious tube, of some kind, must be placed in the nasal duct, but the use of such an instrument has long since been abandoned, as well as all means of dilatation through an opening in the skin. These obstructions are now treated exclusively through the natural channels, and generally through the upper canaliculus. This is slit well down into the sac, and kept open, as mentioned above. For this purpose a Weber's probe-knife is the best instrument. The patient should sit on a low chair, or, better, lie on the operating lounge. The surgeon stands behind the head for the right eye, and in front for the left, using of course his right hand. The punctum must have been dilated, with a conical probe, so as to admit the knife. An assistant renders the canal tense, by drawing the skin of the lid outwards and upwards. The knife is passed in till it reaches the cavity of the sac, and till the blunt point rests firmly against the inner bony wall. Then keeping it firmly there, the hand is slowly raised and the mucous membrane divided well down into the corner. Without withdrawing the knife or relaxing the pressure against the inner wall, it is raised to a vertical position, pushed gently downwards, the edge turned a little forwards, and made to incise or notch the sac. Thus free admission is secured for a large probe.

It is better that the sac should be distended at the time of the operation. This facilitates the different steps, and shows when the sac is well opened, by a gush of mucus. Slight bleeding takes place, but it is soon over. It is seldom necessary to give ether. Waiting a few minutes, the probe may be passed in for exploring and overcoming the stricture. A full set of Bowman's flexible silver probes (Fig. 879) must be at hand. But for safety, and for certainty as to the seat of the stricture, I have for many years used probes with bulbous expansions near the end (Fig. 880). The enlarged end is about ten mm. long, and the thickest portion in the middle. The rest of the instrument is decidedly smaller. Two of different sizes, one two mm. and the other two and one-half mm. at the thickest part of the bulb, may be made on oppo-

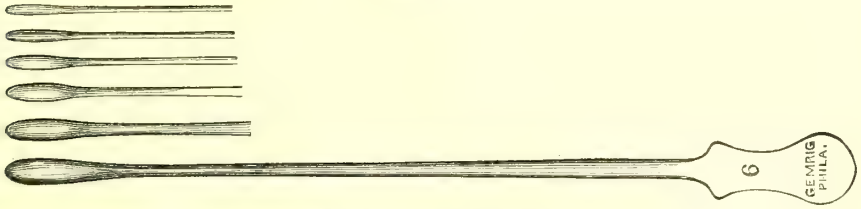
Fig. 879.



Bowman's probes.

site ends of the same instrument, with a flat surface in the centre, as in the double probes. The length of each probe, from the flat middle, should be about five and one-half cm. The probe is gently curved, so as the more readily to pass through the sac and nasal duct, without inconvenience from the prominent brow. It is impossible for such an expansion, when once fairly in the sac or bony canal, to pierce the mucous membrane and make a false passage. When the stricture is reached and the resistance overcome, the yielding is sudden, and indicates its exact seat and extent. If the strictures are multiple, the seat and existence of each are determined.

Fig. 880.



Williams's bulb-pointed probes.

The smaller bulb is introduced first. If the sac is not opened enough to admit it, the notching can be repeated. Great care should be taken to get surely and fairly into the sac with the bulbous end. Then the probe is turned vertically, and pushed gently and slowly downwards in the course of the nasal duct. When the obstacle is reached, a little patience and slowly increased pressure will suddenly triumph over it, and the probe will then pass readily down into the nose, where it is firmly arrested by the solid floor of the inferior meatus. The instrument is then gently withdrawn and the larger bulb passed through in the same way. If the stricture is very rigid and the canal almost closed, some blood will escape from the nose, but otherwise none may be seen. This part of the operation, if skilfully executed, greatly simplifies and expedites the after-treatment. Generally it is better to do nothing more than keep the opening into the sac free for a week or more. If there is much discharge, the sac should be washed out each day with a syringe from above. A dentist's rubber syringe bent at right angles near the end, with a smooth point, and tepid water, are all that is needed. If, when the nozzle is fairly in the sac and directed downwards, the water does not readily flow into the nose and throat, there is something wrong, and the parts should be re-explored. I venture to say, from a large experience, that if in all cases of dilated, suppurating tear sac, with or without fistula, this much were thoroughly well done, and the rest left to nature, most of the patients would be so much benefited as to feel satisfied with the result. In some the troubles will come back, but very seldom, if ever, in the old, aggravated form. In Stilling's mode of treatment, the stricture is deeply incised in different directions, and little or nothing more usually done. Of course, if there is syphilitic or scrofulous caries, with the diseased sac, no very satisfactory result can ever be obtained.

In the hope of securing better results in the long run, I have for many years used the bent silver styles, worn in the duct for several months. They are made of pure, virgin silver, four and one half cm. long, slightly conical at each end, and of different sizes, varying from one to two mm. in diameter. One end is bent into a moderate curve, leaving the straight part three or three and one-half cm. long. Close to the beginning curve the style is again bent outwards, so that when inserted, and the hook turned forwards over the lower lid, it will keep its comfortable position. Otherwise it will be dragged round against the eye by the lid. The outward bend is different for the two sides. By a little experience in the use of the pliers, and in fitting the length to different eyes, it is easy to get the suitable curves and the right length, so that the style will fit close up in the corner, rest gently on the lower lid, be touching or almost touching the floor of the nostril, and be worn without inconvenience or unsightliness. In most cases, I prefer not to use the style. If the thorough operation for freeing the passages, already described, is followed by rapid contraction of the sac and diminution of the discharge, I prefer occasional syringing with tepid water or mild astringents. If the troubles persist, or frequent relapses occur, then a resort to wearing the style may be a great aid. In one respect its use is more agreeable to the patient. After the first few days it is not nearly as painful as dilatation by the occasional passage of the probe. But whatever method of combating the stricture may be thought best in any case, the use of the syringe must always enter freely into the treatment, if there is much enlargement of the sac and profuse secretion. In that event, if the style be employed, it must be removed every day or two for thorough cleansing with tepid water, or the injection of astringents, if that fails. When little or no further secretion is present, the style can be worn for weeks together without removal. The style, of course, must be comfortably fitted to each case, if good is expected. In first placing it, and sometimes in replacing it after removal for syringing, it may not readily enter. Its short, curved, and awkward shape makes the manipulation difficult. When this trouble is experienced, the full-sized probe may be passed and immediately followed by the style. Its reintroduction is more apt to be difficult after the use of astringents to the sac. To combat the discharge, if not promptly cured by wearing the style, syringings with tepid water and astringents must be used. About the best is a ten-grain solution of sulphate of copper, a few drops drawn into the syringe and passed through after thorough cleansing with tepid water.

When the suppuration is controlled, and the patient is allowed to go home, the surgeon should insist on his immediate return if the discharge grows worse in spite of wearing the style and the observance of proper care. After the first thorough operation, if all the symptoms improved rapidly, I would simply cleanse the sac when needed, by tepid syringing, and wait. If the case came to a stand-still, or got worse, I would pass the probe and let it remain for half an hour, once or twice a week, continuing the necessary medication of the sac. If, after a few weeks, the case did not progress well, I would fit a suitable style and see that it was comfortably adapted. Not much attention need be paid to complaints of lachrymation, as long as it is not attended by undue secretion of muco-pus. This can only be remedied by free dilatation of the stricture and faithful medication with the syringe. I have seldom failed to find rapid and great improvement after the first free use of the bulbous probes. In cases with a fistulous opening through the skin, I prefer to pass the probes through it into the sac, and down to the nose. As we have this convenient way into the sac open, immediate and large dilatation of the stricture may be thus practised, and is always followed by closure of the fistula and great amelioration. Now and then, nothing more is needed; but, if required, the upper canaliculus may be slit and the usual treatment continued. Where the sac is so large that no treatment can be expected to bring it to reasonable dimensions, a large portion, or the whole of it, may be dissected out. I did this recently with the happiest result. The patient had chronic ozæna, and profuse suppuration from a large lachrymal tumor. Having etherized her, I made a long incision and dissected out the sac with an enormous diverticulum. The wound was closed with sutures, and healed by first intention, and in a few days she was well. By "well," I mean relieved of the unsightliness and disgusting suppuration. With this she was entirely satisfied. The same result is here obtained as in the old method of destroying the tear sac by the actual cautery. In caries or hopeless closure of the bony duct, destruction of the sac is the best that we can do. Extreme relaxation of the sac is best relieved by enucleation, as above. It is surprising how little such patients are troubled with weeping after the source of the irritation is dried up by obliteration. Such eyes weep when exposed to the wind, or under the influence of the emotions, but not much at other times.

Surgical measures, in the treatment of chronic suppuration of the lachrymal sac, are thus reasonably successful, but the complete cure of the weeping is an exception. Injuries of the canaliculi, especially of the lower, are often seemingly trifling, and yet are followed by incurable lachrymation. If cut across, torn away, or destroyed in their whole length by burns or bruises, it is seldom possible to re-establish their permeability. Great care is required in removing small tumors or other growths from the lids near the inner commissure, not to cut away these delicate but important structures. Rarely, the canaliculus may become obliterated without injury or known cause. At other times, a stricture is found in its course, that can be overcome with a small probe, and the epiphora relieved. The thorough removal of epithelioma of the lids may require the sacrifice of these little ducts, and of course the weeping then is permanent. Occasionally a little calculus may form in the canaliculus, causing suppuration and weeping. It is easily detected and removed, as are the little mushroom growths that cause similar troubles. Persistent weeping is often kept up by ulceration in the nose, and may be mistaken for stricture of the tear passages. I have a patient now under treatment, who came for an operation on the tear sac. She is already relieved by applications to the nasal mucous membrane. Troublesome weeping may also be caused and kept up by a polypus or other growth in the inferior nasal meatus. Such possibilities should never be forgotten, particularly when long standing weeping is not attended by suppuration in the sac itself. Of course, caries of the turbinated bones, or foreign bodies in the nose, may give rise to the same trouble. In the few cases of suppurative inflammation of the tear sac in infants, that I have met with, they have been relieved by a single free dilatation through the opened canaliculus. Calculi and other formations in the tear sac are rare, but must be recognized and removed.

Ophthalmoscopic Diseases.

Alterations behind the lens can only be made out by the aid of the ophthalmoscope. Even in luxations of the lens, the mirror is of great use in diagnosis. For optical reasons, the edge of the lens, when transparent, is seen as a dark border, and readily identified. In the differential diagnosis of cataract, in its incipiency, fundamental illumination of the eye must not be neglected. Oblique illumination alone, in old people, except when distinct striæ are detected in the lens, is likely to lead to a false belief in the existence of cataract. Ophthalmoscopic results may be positive or negative, each kind having its value. In growths of the retina and choroid, at an early period, when clear diagnosis is very important, the eye mirror is indispensable. The functional test must not be omitted. A sharply defined blank in the field of vision (scotoma), in a suspected tumor of the fundus, helps to confirm the diagnosis. Any inflammatory or other organic lesion in the retina, choroid, or vitreous, may give rise to a more or less well-defined scotoma, which is a constant result of detachment of the retina, of hemorrhages, in or under the retina or the choroid, of patches of choroido-retinitis, of tumors in the fundus, and sometimes of foreign bodies, or extravasations of blood in the vitreous. (Plate XXVIII., Fig. 2.) It is not pathognomonic of any one of these lesions. Rarely, it is caused by the embolic plugging of an arterial branch in the retina or choroid. The same defect in the field of vision is sometimes the result of extra-ocular alterations, either in the optic cord or the brain. In such cases, the finding is negative. Lesions of the optic tract, however, are more likely to produce some form of hemiopia or sector defects in the field. In such instances a negative result may be of very positive value in fixing the diagnosis, on the principle of exclusion. The perimeter, or the black board, will enable the surgeon to map out the scotoma.

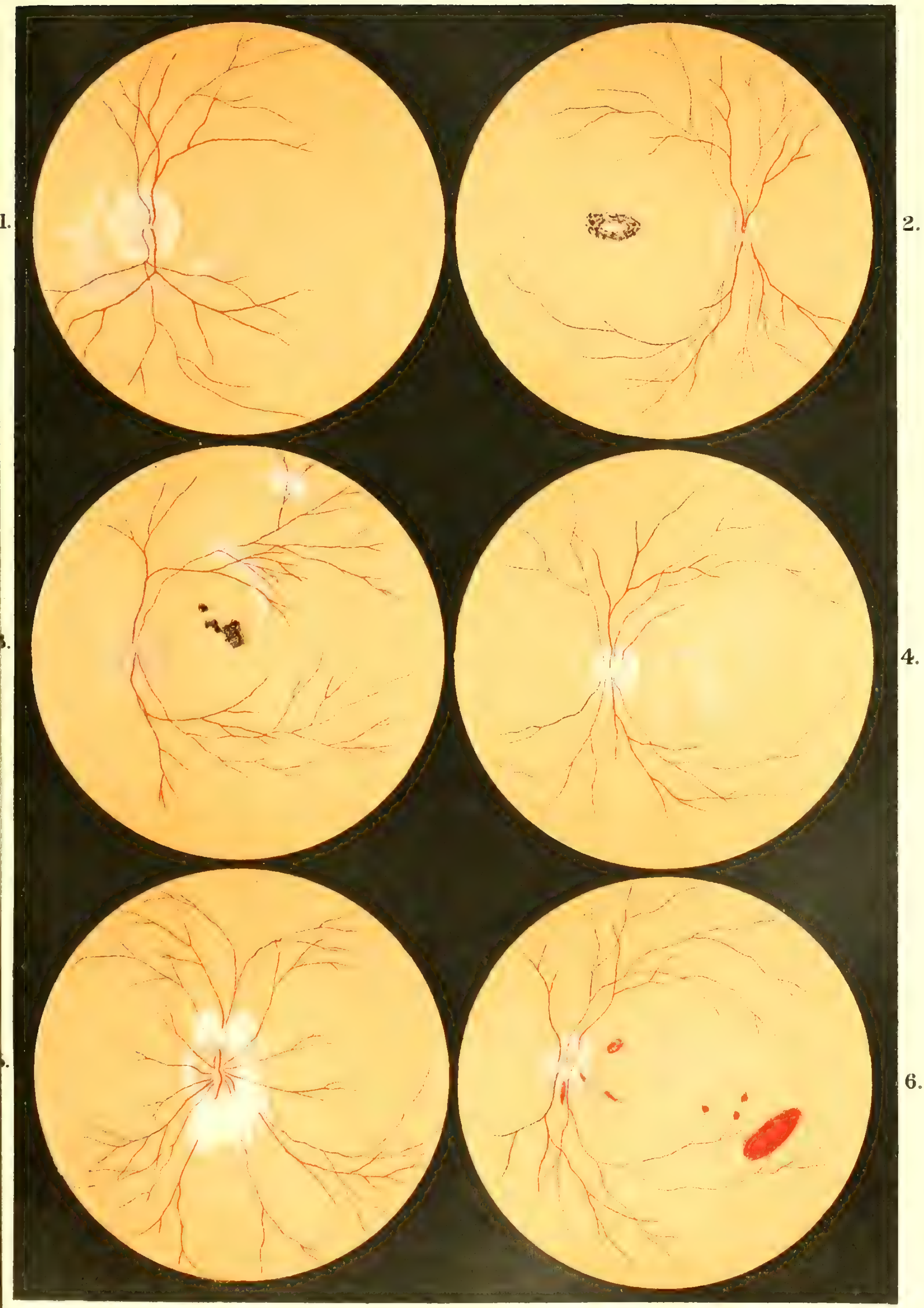
All disorders that lead either to cloudiness of the vitreous, or to profuse intra-ocular hemorrhages, make the illumination of the fundus difficult if not impossible. If the vitreous is semi-transparent, a red reflex may be had from the bottom of the eye, and perhaps glimpses of the optic papilla and other structures. In that case, numerous floating corpuscles will probably be seen in the liquefied vitreous. Slight movements of the eye under inspection help to identify them. If the hemorrhage has been profuse, and close behind the lens, no red reflex can be had from the bottom. The coagulum may then be seen by the ophthalmoscope, or by oblique illumination, in its natural red color. Hemorrhages in the eye are always of serious significance, occurring in the gravest diseases, or indicating a state of the arteries that make apoplectic effusions in the brain very probable. Even spontaneous ecchymosis under the conjunctiva, in itself harmless, is of serious import in persons of advanced years. I have often seen it as the precursor of paralysis. The most hopeless form of glaucoma is that which is complicated by intra-ocular hemorrhages. Indeed, the frequent occurrence of ecchymoses in the retina, in connection with any disease, is an alarming symptom. (Plate XXVIII., Fig. 6.) In old people it portends glaucoma. In the young it signifies a fatal hemorrhagic diathesis. Such cases should be closely watched for years, lest they end in destructive glaucoma. Intra-ocular bleeding, alone or complicating local diseases of the eye, may be indicative of organic lesions of the heart or kidneys, of the hemorrhagic diathesis, of malignant anæmia, or of a degenerated state of the arteries. A rigid inquiry in all these directions should be insisted upon. In rare cases, the phenomenon is unaccountable. I have now under treatment a temperate and well-preserved man of sixty years, who has had the most extensive retinal hemorrhages I have ever seen, first in one eye and then in the other. He seems to be absolutely sound, but is, of course, liable to an apoplectic attack, of which, however, there is now no premonition whatever. If he escapes that, I shall expect to see glaucomatous manifestations at some future day.

In syphilitic choroiditis, the vitreous is often filled with fine opacities, that rise up like clouds of dust when the examined eye is slightly moved. If the turbidity is great, the outlines of the fundus may not be at all visible. At a later period, when this fluid has again cleared, extensive atrophic patches in the choroid may be discovered.

In the acute forms of glaucoma, the cornea, aqueous and vitreous are often so hazy, that direct ophthalmoscopic diagnosis is impossible. Such diagnosis presupposes perfect, or at least partial transparency of the dioptric structures. Opacities in any or all of these, if large and dense, preclude the use of this valuable instrument. Other means of diagnosis must then, especially, be strained into service, as I have already pointed out with some detail.

A false fear of the brilliant light in ophthalmoscopic examination, prevails among patients. But in intelligent hands there is no danger whatever. It

PLATE XXVIII.



Morbid Conditions of the Eye-ground.

H. BENCKE, LITH. N.Y.

is always best to look a little obliquely into the eye, at first and at all times, except when the region of the macula lutea is inspected. In this way the light is not at all painful, nor even dazzling. In the diagnosis of delicate changes in the direct line of vision, dilatation of the pupil is indispensable.

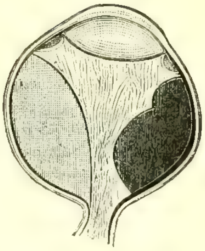
There are two methods of examining the eye with the ophthalmoscope —one called the direct, and the other the reversed. In the former, the objects in the fundus are seen in their natural relations. With the latter, they are reversed, above appearing below, and right left. We speak likewise of the erect and the reversed image. In direct examination, the examined and examiner's eye must be naturally emmetropic, or rendered so with glasses, and the accommodation in both relaxed. Moreover, the surgeon must approach as closely as possible the eye inspected, bringing his eye almost in contact with it. To do this successfully, the right eye must be trained to look at the right eye of the patient, and *vice versa*. In this way alone can he avoid colliding of noses. By the reversed method, with a convex lens of three or four inches held before the examined eye, there is greater liberty, and all sorts of cases can be examined with more ease. Both methods should be employed in most instances, the one helping to control and explain the other. In ophthalmoscopic examinations, the parallactic movement of objects, at different depths in the eye, is very striking and of great value. This phenomenon is particularly useful in judging of opacities in the vitreous, and estimating excavations of the optic papilla, as in glaucoma. Beginners are very prone to diagnose *congestion* of the optic nerve, but experts know the extreme difficulty of recognizing this condition, and are more cautious. Serious impediments to the retinal circulation lead to swelling of the papilla, tortuosity of the veins, ecchymoses, and other unmistakable alterations. As the percipient elements of the retina, the rods and cones, as well as the vitreous humor, are nourished by the chorio-capillaris of the choroid, it follows that in nearly all the serious disturbances of the choroidal circulation, the vision is impaired, and the vitreous becomes cloudy. Effusions into the vitreous, from the optic nerve or retina, or hemorrhages, remain close to the part diseased. Impairment of sight from lesions of the choroid, involving directly the terminal nerve elements, is much greater than in more marked changes in the vascular layer of the retina. It is often amazing to find very slight dimness of vision in enormous swelling of the optic nerve, and in other alterations equally grave of the retina. It is not safe to base an opinion of the severity of slight disturbances, on the ophthalmoscopic appearances. Functional tests must always be applied first, and are often surprising. A set of test types, which is easily obtained, will enable the surgeon to try the acuity of vision, both for distance and for reading, and to ascertain the accommodation.

A critical examination of the eye and its delicate functions, is often an important aid in the diagnosis of diseases elsewhere. For example, in tumors within the cavity of the cranium, we often have optic neuritis, involving both eyes. Its presence in the two eyes at once, or in short succession, directs suspicion to the brain immediately. It may appear at any period of the morbid growth, and usually persists till the fatal termination, often lasting for years with its most characteristic symptoms. These are great swelling and prominence of the papilla, extreme tortuosity of the retinal veins, blurring of the natural boundaries of the disk, and, frequently, patches of extravasated blood in the retina. Single optic neuritis from other causes, is frequent; as in young women with suppressed menstruation, in syphilitic and albuminuric subjects, and in some instances where no general disease can be made out. It is sometimes a grave symptom of lead-poisoning, and is apt to lead to atrophy and great damage to vision, if not to its total abolition. Single or double, it is occasionally recurrent, coming or going with fluctuations in the disturbances that give rise to it. In children with tubercular meningitis, neuro-retinitis is rarely detected. In such subjects, tubercular deposits in the choroid are more frequent. Optic neuritis in a milder form, but combined with very striking, and often characteristic, changes in the retina, is a frequent indication of albuminuria. Sometimes the retinal changes alone are detected, and these have often led me to the diagnosis of serious disease of the kidney before it has been suspected by the attending physician. A chalky-white group of deposits, often radiating in lines from a centre, and usually in the region of the macula lutea, at once suggests a renal origin. It is rarely seen in other diseases, and in albuminuria is not always so characteristic. (Plate XXVIII., Fig. 4.) Retinitis in any form should lead us always to inquire into the constitutional condition of the patient. Retinal diseases are more common than cataract, in diseases of the kidneys, but both may exist together, and hemorrhages into the eye are not at all uncommon.

In locomotor ataxia, certain eye symptoms are among the first to attract attention. Diplopia from disturbances in the rotatory muscles of the eyes, is very common. I recall the case of a man whom I treated for paralysis of the external rectus of one eye. He recovered from this, after a long course of treatment which lasted about a year. Some years after, he consulted me for a failure of vision in one eye. My attention was then attracted by his very small pupils. With the opthalmoscope, I recognized some pallor of the optic papilla, the first evidence of optic atrophy. This continued slowly to increase, with failure of vision, till he is now totally blind, not even perceiving light. His pupils have remained very small from the beginning. As long as useful sight continued, the size of the pupils was uninfluenced by varying degrees of light. But the moment a small object, held near him, was focused, the pupils contracted, to dilate to their usual small size when accommodation ceased. This failure to respond to light, and movement with efforts of accommodation, are characteristic of tabes dorsalis. This peculiarity of the pupils and optic nerve-atrophy, with failing sight, often precede, for months and even years, the disturbances of muscular equilibrium. The patient just referred to, still walks well, and has perfect use of his mental faculties, though long since completely blind. I call attention to this state of the pupil, in connection with the ophthalmoscopic evidences of optic atrophy, on account of its diagnostic importance. (Opacity of the optic nerve-fibres is shown in Plate XXVIII., Fig. 5.)

INTRA-OCULAR TUMORS.—I have only spoken of these neoplasms incidentally, in treating of the diagnosis of eye troubles without the use of the ophthalmoscope. Whatever be the nature of these growths, and whether commencing in the retina or choroidal tract, destruction of sight is the inevitable consequence. If not removed very early, the system will be contaminated, and fearful suffering with a fatal result is sure. Indeed, even when detected in their first development, and the eye at once enucleated, relapse and a lethal termination are very apt to occur. The fact that an experienced surgeon will not promise a certain cure, often leads patients to wait and take the risks, rather than submit to enucleation. Mutilation, with a certainty of saving life, is hard to submit to; but when no great assurance is promised against relapse, most persons prefer trusting to Providence. Still, an early enucleation may and often does afford permanent protection. Even if it fails, a respite is secured, and the extreme agony of a cancerous eye is avoided. An intra-ocular growth is often far advanced before it is detected. This is especially apt to be the case in small children. Till the eye is distended by the neoplasm, there is little or no pain. But glaucomatous hardness and paroxysms of extreme suffering come at last. In this stage, the diagnosis is usually easy. Still, in adults, the case may be mistaken for simple glaucoma, till later developments. Now and then, I have seen a sarcomatous tumor developing in the ciliary region, mistaken for cataract or for a luxated lens. A very little skill will prevent such a blunder.

Fig. 881.



Section of eyeball showing an intra-ocular tumor.

The annexed wood-cut (Fig. 881) represents the section of an eye removed from a lady 39 years of age, who, about six months before coming under observation, accidentally discovered that her right eye was very imperfect. She could barely see objects around the room. The eye up to that time had never been painful, and had never been injured, but since then the eye had become entirely blind, and was now at times quite painful. The eye was abnormally hard. The iris was pressed forward, in contact with the cornea, and it was impossible to obtain more than a red reflex from the fundus, and that only on the inner side. On the outer side was seen the rounded outline of a choroidal tumor. The eye was enucleated December 9, 1881, and after hardening in Müller's fluid was opened by vertical section. The tumor was found attached outwardly, and was 18 mm. in length and 8 mm. in thickness. The retina was detached and funnel-shaped.

EXPLANATION OF PLATES ILLUSTRATING INJURIES AND DISEASES OF THE EYES.

PLATE XXVII.

Fig. 1. Episcleral Angeioma.
Fig. 2. Cyst of Iris, after removal.
Figs. 3, 4. Multiple Pupils of both Eyes.[1]
Fig. 5. Buphthalmus.
Fig. 6. Penetration of Birdshot through Ciliary Region.

PLATE XXVIII.

Fig. 1. Rupture of Choroid.
Fig. 2. Central Choroiditis with Scotoma.
Fig. 3. Rupture of Choroid with Pigmentation from Retinal Hemorrhage.
Fig. 4. Retinitis Albuminurica.
Fig. 5. Opaque Optic Nerve-fibres.
Fig. 6. Acute Neuro-retinitis with Hemorrhages.

[1] From a patient sent by Dr. C. Kearns, of Covington, Kentucky.

INJURIES AND DISEASES OF THE EAR.

BY

ALBERT H. BUCK, M.D.,

OF NEW YORK.

EXAMINATION OF THE PATIENT.

TESTS OF THE HEARING POWER.—In all the different forms of ear disease, with the exception, perhaps, of those of the auricle, it is a matter of great importance to ascertain how far the patient's power of hearing is impaired. In the case of an adult, considerable dependence may be placed upon the individual's own statement with regard to this point; but in that of a child, the information desired must be obtained from the parents or guardian. It will not do, however, to depend entirely upon this sort of evidence: we must supplement it with that which may be obtained by means of certain simple tests. The ticking of a watch, and words or sentences spoken either in a whisper or in an ordinary tone of voice, constitute the only tests which have ever been employed to any great extent. Of the two, that which is based upon the employment of articulate speech, is the one more commonly employed, and the more satisfactory. At first we employ it, not in a formal manner and with the consciousness that we are using a test, but unconsciously, in the simple routine of ascertaining the patient's history. If in this way we have learned that only one ear is probably affected, our judgment with regard to the patient's general acuteness of hearing cannot safely be taken as furnishing a correct estimate of the hearing of the affected ear. A more formal test then becomes necessary. For example, the patient should be told to close firmly the unaffected ear with his finger, and to sit or stand in such a position that the physician's voice may be directed toward the affected ear, which remains open. In the case of patients who are decidedly deaf in both ears, we must not forget the fact that they often possess the power of "reading the lips" to a remarkable degree. Under these circumstances the patient should sit with his face turned toward the physician, but with his eyes closed. Furthermore, he should be required to repeat the exact words spoken by the physician. In testing the hearing with the watch, it is better to hold it first at a point which lies beyond the hearing distance of the ear which is being tested, and then to gradually bring it nearer and nearer to the ear, until the patient is able to distinguish the sound of the ticking. As a rule, it is not necessary to ask the patient to close the other ear during the progress of the test, as the ticking of an ordinary watch is a sound of too great feebleness to reach the opposite ear. The proximity of a wall, door, or other reflecting surface, may, however, render such a precaution necessary. If the hearing is markedly affected, the ticking of the watch may not be heard even when it is pressed firmly against the auricle. In this connection it should be remarked that a patient who fails to distinguish the sound of the ticking when the watch is pressed against the auricle, will often hear the sound quite distinctly when the watch is pressed against the temple, or against the mastoid process. In the case of a young child, we are obliged to depend very largely upon the statements of the parents with regard to the condition of the hearing.

A tuning-fork so constructed as to maintain its vibrations for a comparatively long time, and not pitched higher than the middle range of the musical scale, will be found very useful for the purpose of communicating sonorous vibrations to the auditory nerves through the skull.[1] It is not always an easy matter, however, to determine correctly the significance of the results of this test. In a certain class of cases, the test produces results which are positive, and which can only be interpreted in one way. I refer to those cases in which the sound of the tuning-fork is heard better by the patient in the affected than in the unaffected ear. It is evident, in such cases, that the deafness complained of is not due to any lack of power in the auditory nerve, and that we are simply dealing with phenomena of reflection and reinforcement of sound, such as may be produced by a swollen drum membrane, or by cerumen impacted in the external auditory canal, or by a finger placed lightly over the outer orifice. In another class of cases, however, the problem is not so readily solved. In these cases, the patients have recently become markedly or completely deaf in one ear, and, when we subject them to the tuning-fork test, we find that they hear the sound of the fork only in the unaffected ear. In such cases it has been customary to maintain that the auditory nerve must be the seat of the lesion which has caused the deafness. This is not the place in which to discuss this question in detail, and I will therefore simply state my own belief with regard to it in very brief terms. Changes in the drum-cavity, and particularly in those parts of it which are known as the oval and round windows, are, it appears to me, competent to prevent the perception of sounds by the adjacent auditory nerve. In order that the auditory nerve may transmit sound-sensations to the brain, it is necessary that a vibratory motion should take place in the cochlear structures among which the auditory nerve-filaments terminate. No provision exists in these structures for lateral vibration, but only for one following a direction at right angles to the plane of the lamina spiralis. Such a mode of vibration, however, can only take place when at the same time both the foot-plate of the stirrup and the secondary tympanic membrane are mobile; or, in other words, when the increase in breadth of the column of fluid occupying the scala vestibuli can be compensated for by a corresponding diminution in breadth of that occupying the scala tympani; for these changes in the diameters of the two columns of fluid represent the mechanical result of an excursion inward (toward the vestibule) of the foot-plate of the stirrup, while upon the return excursion of this ossicle (outward toward the tympanum), the relations of the diameters of the two columns of fluid are reversed. This brings us then to the following conclusion with regard to the loss of power to perceive sound under the circumstances mentioned above, viz., that this loss of power may be produced by any one of the following conditions, beside that of actual paralysis of the nerve itself:—

1. Immobility of the foot-plate of the stirrup.
2. Immobility of the secondary tympanic membrane.

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[1] The heavy, prismatic tuning-forks are the best, as they maintain their vibrations for quite a long time. They are kept for sale by all the surgical instrument-makers, and may be used either with or without clamps. The common practice is to strike one branch of the fork flatwise against some hard object, covered with cloth or leather, and then, while the instrument is still vibrating, to rest the lower end of the handle against the forehead, the top of the head, or the teeth of the patient.

3. Marked increase in the tension of the fluid contents of the labyrinth, due to
   - *a.* rupture of a bloodvessel and escape of blood into the labyrinth;
   - *b.* simple fulness of the bloodvessels;
   - *c.* extreme pressure of the foot-plate of the stirrup upon the labyrinthic fluid; all of which conditions are competent to greatly increase the pressure upon the contents of the labyrinth.

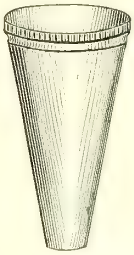
In actual practice these distinctions are of little value. At the same time, they sometimes help us to explain satisfactorily those rare cases in which the hearing is rapidly lost, and then afterward is almost as rapidly restored.[1]

Instruments and Methods of Examination.—It is a matter of the first importance that the physician who contemplates studying diseases of the ear, should be provided with good instruments. Badly devised or clumsily constructed instruments will make it impossible for him, in many cases, to arrive at a correct diagnosis, and, in other cases still, he will, by their use, cause the patient much unnecessary discomfort or even pain.

In a few individuals, the external auditory canal is so broad and straight that the physician can see its walls throughout their entire length, and even the drum-membrane, by direct inspection, without the aid of instruments of any kind. In the majority of persons, however, a satisfactory view of these regions cannot be obtained except with the aid of two kinds of instruments, viz., one to push aside the soft walls of the orifice of the canal (ear specula), the other to illuminate the parts thus rendered accessible (mirrors of various kinds).

Of the different patterns of *ear speculum* which are offered for sale in the surgical instrument-makers' shops, the cheapest and at the same time the best is that known by the name of Wilde's ear speculum. (Fig. 882.) This instrument represents a truncated, hollow cone of coin silver, polished within and without. The cheaper variety, which is made, I believe, of "German silver," is a very poor substitute for that made of coin metal. For all ordinary demands, three different sizes of ear speculum will be found sufficient. They should all be of about the same length, but their calibres should differ. The aperture, at the smaller end of the instrument, should measure not less than three and a half millimetres in diameter, for the smallest of the three specula, and not more than seven millimetres for the largest. The walls of the instrument should be no thicker than is sufficient to prevent them from bending under ordinary manipulations. It is scarcely possible at the present time to purchase ear specula that are not very faulty in this important respect. It is necessary to have them made to order.

Fig. 882.



Wilde's ear speculum.

For purposes of illumination, either the *hand-mirror* or the *forehead-mirror* may be employed. As far as the mirror itself is concerned, these two are one and the same thing. In practice it has been found that the best illumination is obtained with a concave mirror of circular form, and possessing a focal distance of from twelve to thirty centimetres, according to the requirements of the visual power of the observer. A focal distance of about twenty centimetres is that which is best adapted to all the ordinary purposes of the aural surgeon. If the mirror be held in the hand, it is probably better to place the eye in the focal line, that is, to look through the small central aperture with which these mirrors are usually provided. If the instrument, however, be worn on the head, the mirror should be brought down so as to rest on the bridge of the nose, or in close proximity to it, and the physician should look into the ear over the upper edge of the mirror. Here, again, it will be found that the forehead-mirrors kept for sale in the instrument makers' shops, are not constructed with a view to their being employed in this fashion, the space left between the upper edge of the mirror and the forehead-plate being almost invariably too narrow. They are also, as a rule, defective in another respect, viz., that the ball-and-socket joint, by which the mirror is attached to the forehead-plate, allows the former to be rotated to such a limited extent, both from side to side and from before backward, that the observer will often find himself unable to use the source of light which may happen to be available, unless he changes its position, or that of the patient, or both. This joint should have the greatest freedom of motion possible, for then only will the physician readily be able to utilize almost any source of light that he may find at hand. The accompanying cuts (Figs. 883, 884) show the details of construction so well, that I may omit any further description of this instrument, which I consider to be a thoroughly serviceable type of forehead mirror. As represented in the cuts, this mirror is essentially the same as that first devised by Dr. Robert F. Weir, of this city, in 1869 or 1870. At that time the forehead-plates were usually made of hard rubber, but now the best are made of metal, with an outer plating of nickel. There should be no padding, and the flexible band attached to the plate should not be made of any dyed material, as the moisture of the temples is apt to make the dye run.

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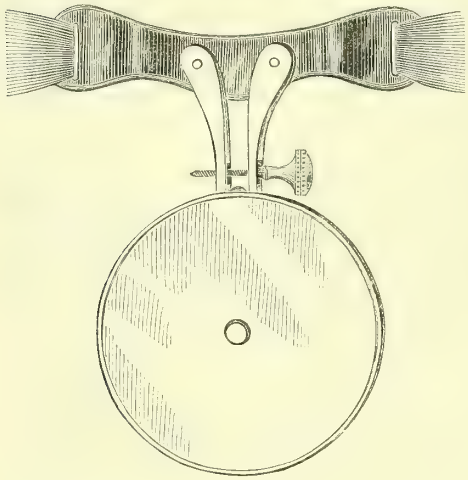
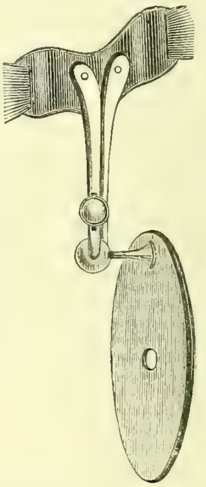
[1] I have recently seen a case of chronic congestive catarrh of one middle ear, in which, during some of the exacerbations, the hearing power of one ear (for sounds of either the voice or the vibrating tuning-fork pressed against the forehead) was completely obliterated. With the subsidence of the more marked congestion of the tympanic mucous membrane, the hearing returned to a very useful degree, the patient being able to correctly distinguish words spoken in an ordinary tone of voice at a distance of ten or fifteen feet.

Fig. 883.



Forehead-mirror. (Half the natural size.)

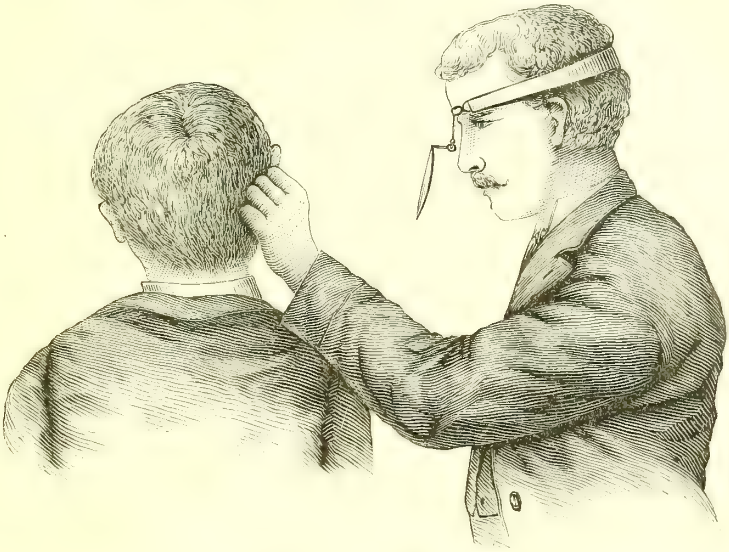
Fig. 884.



Forehead-mirror. Profile view.

As far as the *actual examination* of the auditory canal and drum-membrane is concerned, I shall mention only the points which are of the most importance. Among the readily available sources of light for illuminating the deeper parts of the ear, the best is the broad flame of a burning gas-jet (preferably the argand gas-burner), or that furnished by a good kerosene lamp. Even a lighted candle, if held sufficiently near, may suffice. Direct sunlight is too dazzling. Indirect sunlight, such as can be obtained if we direct our mirror toward the sky above the horizon, or toward the white wall of a neighboring house, generally affords sufficient illumination for all ordinary purposes. If artificial light be used, it should be placed somewhat above the level of the patient's head, and a short distance to the right or to the left of a line drawn through the heads of the patient and the surgeon who is making the examination. At first, considerable difficulty will be experienced in securing a steady and good illumination of the deeper parts of the auditory canal, but with practice will come comparative ease in overcoming these difficulties. In this connection I wish to call attention to an important rule, viz., that in his efforts to cause the rays of light to fall upon the patient's ear, the physician should not depend upon the motions of his neck for the attainment of this object. After he has once placed his head in the position which is best adapted to the purpose of directly looking into the ear, he should keep it in that position, and the satisfactory illumination of the parts should be effected wholly by movements of the mirror proper, through the medium of its ball-and-socket joint attachment to the forehead-plate. A strict observance of this rule will greatly facilitate the task—by no means always an easy one—of obtaining a good view of the deeper parts of the auditory canal.

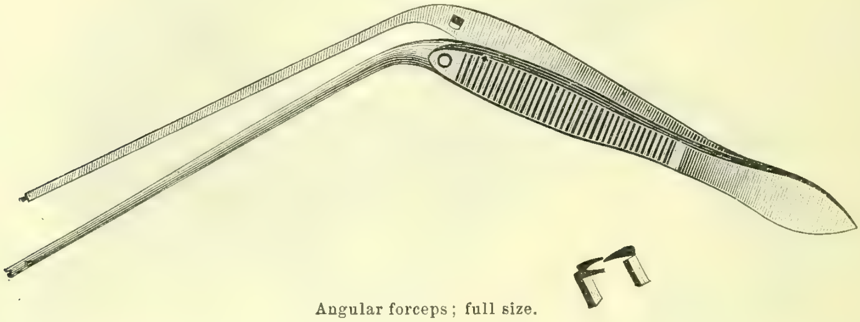
Fig. 885.



Forehead-mirror in actual use.

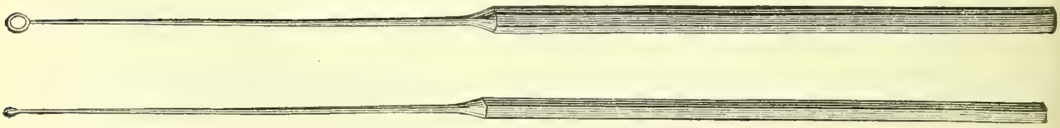
In making the actual examination, we must not forget one or two points of practical importance. In the first place, in the adult, the outer third of the auditory canal, the cartilaginous portion, usually forms an obtuse angle with the inner portion of the canal. To render the meatus straight throughout its entire length, we need only to pull the auricle slightly upward and backward. In infants, we may find it necessary to pull the auricle rather outward—away from the skull—and downward, in order to attain the same object. In the next place, if we wish to avoid the danger of wounding the walls of the meatus, we should keep our eyes directed upon the parts illuminated at the bottom of the speculum, which is being gradually pushed, by a sort of boring motion, farther and farther into the canal. It is not necessary to push the instrument beyond the point at which a good view of the membrana tympani can be obtained. If we meet with obstructions, in the shape of cerumen, hairs, scales of epidermis, pus, etc., we must remove these, and for this purpose we shall find certain instruments almost indispensable. To most persons the syringe will suggest itself as the proper instrument to employ for the removal of any such obstructions in the canal. Others will employ by preference delicately constructed angular forceps, with toothed ends (as shown, considerably magnified, in the cut), especially if the obstruction be of such a nature that it may readily be grasped between the blades of such an instrument. If the body be more firmly lodged, the curette, or a slender silver probe, will be found very useful in loosening it from its attachments to the walls of the canal. Probes and curettes are important accessory instruments. In very many cases, simple inspection of the parts leads us to wholly erroneous conclusions with regard to the true state of things. I might enumerate a great variety of pathological conditions which even the most experienced specialist would be very likely to interpret incorrectly, if he were not allowed to use the probe as a means of confirming or correcting the judgment which he had arrived at by simple, unaided inspection. Both the probe and the curette, however, must be delicately constructed, or the surgeon will find them of comparatively little use, either as aids in making a correct diagnosis, or as substitutes for the forceps and syringe. The accompanying cuts show sufficiently well the size, shape, and dimensions of these two valuable instruments. The curette is made of polished steel, and the probe of soft silver, without alloy. In the drawing of the probe, both the knobbed end and the adjacent portion of the shank are thicker than they should be. The ring-shaped end of the curette has carefully rounded edges.

Fig. 886.



Angular forceps; full size.

Figs. 887, 888.



Curette and slender probe.

I never use this instrument as a scraper, but simply as a dissector, that is, as a means of loosening objects from their underlying attachments.

Diseases and Injuries of the Auricle.

Eczema.—The commonest affection to which the auricle is liable, is eczema. Among the children of the poorer classes it is an extremely frequent disease, and, on careful inquiry, it will generally be found that the cause is of a threefold nature. In the first place, some direct source of irritation is necessary, and this will usually be found in the shape of a discharge from the external auditory canal. In the next place, in a properly fed, properly washed, and healthy child, the mere presence of a discharge from the meatus should not lead to more than a very limited eczema of the parts immediately bordering on the orifice of the canal. Hence we may safely assume, in cases of extensive eczematous inflammation of the auricle, that the child is neither properly bathed nor properly fed. As the result of feeding a child, of from one to five years of age, on pastry, tea, coffee, bananas, salt meats, etc., two things are apt to take place: the discharge from the ear assumes a highly irritating, in some instances positively corrosive, character; and the skin, not merely of the auricle, but also of other parts of the head, becomes so prone to inflammation that the slightest irritation from without suffices to develop a small furuncle, or an inflammation of a more extended character, like that observed in eczema. In adults these three factors—the presence of an irritating discharge from the ear, lack of cleanliness, and an improper diet—which are so generally the chief causes of the disease in children, are frequently lacking, and we are tempted to assume the existence of a constitutional vice or predisposition—by which I mean the circulation, in the blood, of certain elements which keep the skin in an irritable condition.

A mere redness and slight infiltration of the skin characterize the disease in its simplest form. When the affection becomes more pronounced, we shall find crusts or scabs covering the inflamed skin. In its most aggravated form, the auricle may present an almost continuous mass of scabs, and beneath them, in some spots, the skin will be found to be quite deeply ulcerated.

The *prognosis* of this affection is almost unqualifiedly favorable, though in elderly individuals it sometimes proves rebellious. The *treatment* should be both general and local. In children, the most important thing is to secure strict cleanliness, both with regard to the outside parts and with regard to the auditory canal. The child's diet should then be carefully regulated, and wholesome bread, butter, oatmeal, hominy, milk, fresh meat, and simply cooked vegetables, should be substituted for the unwholesome articles of diet which the child has previously been permitted to eat. In adults we may also find it desirable to prescribe a simpler diet, and abstinence from alcoholic beverages. In the majority of cases, moreover, we shall find that the patient does not take sufficient exercise in the open air, and we should be careful to direct attention to this point. It is also important to secure free and regular action of the bowels.

The local measures to be employed must vary according to the stage or condition in which we may find the eczema. Thus, for example, the auricle may be in a condition of such acute inflammation that cooling applications, or even local blood-letting by means of leeches, may be required. Such an acute eczema of the auricle is not often seen, and if the parts are merely red and swollen, we may prescribe at once the free use of an ointment consisting of oil of cade and vaseline, in the proportion of from two to five drops of the former to two drachms of the latter. The stronger preparations, such as

I used to prescribe a few years since, not infrequently increase the existing irritation; for this reason I now use habitually, and with equally good results, the weaker preparation mentioned above. It is important to keep this ointment constantly applied to the affected parts, by means of such dressings as will secure this result. All crusts and sheets of exfoliated epidermis must invariably be removed before the ointment is applied, and if there are any points at which actual ulceration has taken place, these must be touched with nitrate of silver, either in its crystalline state or in the form of a strong solution. In very many cases, a single, superficial application of the caustic suffices to remove, in from twenty-four to forty-eight hours, every trace of ulceration. Deep cauterization aggravates the evil.

As substitutes for the oil-of-cade mixture, either simple vaseline, or the benzoated oxide-of-zinc ointment, or Hebra's diachylon ointment, may be used.[1] Finally, whatever preparation we may decide to use, the necessity of carefully cleansing the affected skin, at least once a day, with warm water and Castile soap, or tar soap, must not be forgotten; and in drying the parts, care must be taken not to apply any more friction than is unavoidably necessary. Furthermore, it is a good plan to continue the local treatment for a few days after the parts present every appearance of having been restored to a normal condition.

SIMPLE DIFFUSE INFLAMMATION.—When hot poultices have been kept for too long a time in contact with the auricle, a diffuse and painful inflammation of the skin covering this part is excited. Precisely the same sort of inflammation is occasionally observed in the course of an acute attack of purulent inflammation of the middle ear, after the discharge has begun to escape by way of the external auditory canal. A differential diagnosis between such a simple diffuse inflammation and one of either eczematous or erysipelatous nature, is at times impossible. If it does not extend beyond the limits of the auricle, I think we may exclude erysipelas. If there are no evidences of eczema, either in the past history of the ear or in the presence of a desquamative eruption in the vicinity of the inflamed part, we may exclude that disease, and so, by exclusion, reach the diagnosis of simple, diffuse inflammation. A moderate rise in temperature is possible in all these conditions: hence the thermometer does not afford us material assistance in reaching a correct diagnosis.

Cooling applications constitute the chief and often the only remedy required.

PERICHONDRITIS (*Othæmatoma; Chondromalacosis; Chondromalacia; Hæmatoma Auris*).—A perichondritis of the auricle may develop spontaneously through degenerative disease of the cartilaginous framework, or it may owe its origin purely to outside influences, such as a blow, a burn, or a frost-bite. In the latter case, we are unquestionably dealing with a genuine inflammation of the fibrous nourishing membrane which closely envelops the cartilage of the auricle, and which sends vascular shoots through it at numerous points. In the former case, the pathological processes may be more appropriately designated by the term *chondromalacosis* than by that of perichondritis, inasmuch as softening and death of the cartilage precede and apparently give rise to the inflammatory changes in the overlying perichondrium.

As a rule, it is only after the disease has been in progress for some time, that the surgeon has an opportunity of studying its manifestations. The picture presented to his eye is very commonly that of a red and tense swelling of the central and upper portions of the auricle. Fluctuation is easily recognized, and an incision affords escape to a yellowish, or pinkish, and rather sticky fluid. In some cases the tumor is almost black in color, and dark blood is evacuated by an incision. If exposure to excessive heat or excessive cold be the cause of the perichondritis, two or three isolated centres of disease may be found.

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[1] For Hebra's formula, see Vol. II. page 614, note.

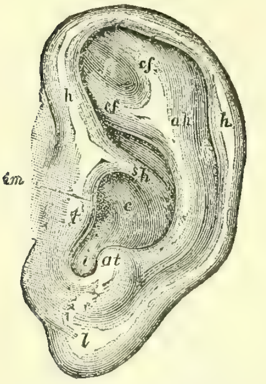
At a still later stage areas of ulceration may be seen, and frequently, in cases of chondromalacosis, there may be more or less thickening and deformity of the intervening parts. I have known the auricle to present, under such circumstances, every appearance of being cancerously affected.

The *prognosis* in this class of cases has reference simply to the degree of deformity which is likely to result from the disease. In simple perichondritis the prognosis is favorable. If the abscess or collection of fluid is opened early and freely, very little, if any, deformity will be left after the parts have healed. In chondromalacosis, the degree of permanent deformity will depend chiefly upon the extent of cartilage destroyed, and only to a slight degree upon the inflammatory thickening of the perichondrium.

In the matter of *treatment*, we must be guided by the condition or stage in which we find the disease. If a tense, fluctuating swelling exists, we should incise it and evacuate the fluid contents of the tumor. Care must be taken not to make too small an incision, as our aim should be to place the diseased parts in such a condition that we may easily keep them thoroughly clean, and at the same time may with equal facility bring our remedial applications—nitrate of silver or tincture of iodine (either the simple or the compound tincture)—in contact with them. In some instances, pressure will promote the healing of the parts that have been kept separate for some time by fluid effusion. Cod-liver oil and a more generous diet will be found useful adjuncts in the treatment of many of these cases.

New Growths.—Among the tumors of which the auricle may become the seat, the most common are undoubtedly the *fibroid* growths of the lobule. Their origin can very often be traced to the irritation produced by the wearing of an ear-ring. As a rule, they do not attain a size larger than that of a filbert or a hazel-nut, but in exceptional cases they have been known to grow to the size of a hen's egg. Negresses, it appears, are peculiarly liable to acquire fibroid growths of the lobule of the ear. The best plan of removing these tumors is to include the mass in a V-shaped incision, great care being taken to remove every trace of the growth, as otherwise, in a short time, a second one may be looked for at the same spot. Relapses, indeed, have repeatedly occurred, after the greatest care had been taken to remove every portion of tissue that seemed in the slightest degree likely to contain the germs of a new growth of the same nature. I remember a case of recurrent fibroid tumor of the auricle, in which the most careful search with the microscope failed to discover any cellular elements in any part of the mass. Angeioma and epithelioma of the auricle occur with nearly equal frequency, and both forms of tumor are much less common than the fibroma. In the early stage of an *epithelioma*, excision of the growth with a V-shaped portion of the periphery of the auricle, is the proper treatment to adopt; but at a later stage, when there are scattered foci of the disease—some of them too small to be distinguished by the naked eye—nothing short of complete amputation will suffice to arrest the advance of the malady. In cases of *angeioma*, Prof. Politzer recommends the employment of Paquelin's thermo-cautery. If the vascular tumor be of small size, he says that it may be destroyed at a single sitting, but that in the larger tumors the cauterization should be confined to a limited area, and that the procedure should then be repeated, as often as may be found necessary, at intervals of five or six days. He also advises that, if any large artery (for example, the posterior auricular) be found acting as a feeder to the growth, it should be tied percutaneously. The danger of hemorrhage, after the use of the cautery, must also be constantly borne in mind. According to the same author, ligature of the carotid should not be resorted to until after the repeated use of the cautery has demonstrated clearly that the tumor cannot be destroyed by its employment. Successful results following ligature of the carotid have been obtained by Dupuytren, Mussey, and Weinlechner. Syphilitic *gummata* are sometimes observed on the auricle. Genuine *fatty* tumors, *horn-like* growths (*cornu humanum*), and the various forms of *sarcoma*, are quite rare.

Fig. 889.



Auricle (after Urbantschitsch). *ah*, Antihelix; *at*, Antitragus; *c*, Concha (fossa conchæ); *cf*, Crura furcata; *fi*, Fossa intercruralis; *fs*, Fossa scaphoidea; *h*, Helix; *i*, Incisura intertragica; *im*, Introitus meatus audit. extern.; *l*, Lobulus; *sh*, Spina (crista) helicis; *t*, Tragus.

Contusions and Wounds of the Auricle.—Serious wounds and other injuries of the auricle are not as common, at least in our large cities, as one would be led to expect from the exposed position of this part of the body. *Contusions* are quite frequently observed, but they generally require no special treatment beyond the employment of the simple measures which tend to allay inflammation. In the few cases in which the damage done has been sufficiently serious to set up a perichondritis, the treatment described as appropriate for that condition is the proper one to pursue.

Wounds made with any kind of cutting instrument, are apt to result in a separation of a part of the auricle from the rest of the organ. This separation may be complete or incomplete. If it be incomplete, the opposite raw edges should be brought into exact coaptation, and held in that position either by sutures or by a network of cotton fibres over which collodion is freely applied. I remember an instance in which the cut extended through the entire thickness of the auricle, from the fossa conchæ, in the immediate neighborhood of the orifice of the external auditory canal, to the outer edge of the helix (see Fig. 889). The patient was intoxicated when the accident occurred, and remained in bed for three or four days without doing anything for the ear. By that time I found the raw edges of the wound granulating and bathed in pus. Nevertheless, very good results were obtained by simply bringing the raw edges carefully together and keeping them in position by means of cotton fibres and collodion. If the separation be complete, one part falling to the ground, union may still be expected to take place, provided that the severed fragment of the ear be carefully cleansed, and, as soon as possible, placed firmly in the position in which it belongs. To favor healing as much as possible, a covering of fine cotton or wool should surround the auricle, and thereby maintain the temperature of the separated fragment at a proper point. Triquet[1] mentions two well-authenticated instances of restoration of vitality in a severed portion of the auricle, and Schwabach[2] says that this successful result is often obtained after student-duels, in which a part of the auricle has been cut off by the sword.

The condition known as *cleft lobule* (due to wearing heavy ear-rings) is of common occurrence. The treatment consists in cutting away the opposite, cicatrized skin-surfaces, and then stitching the parts together as accurately as possible.

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[1] Traité pratique des maladies de l'oreille. Paris, 1857.

[2] Eulenburg, Real-Encyclopädie. 1882.

Deformities of the Auricle.—Autoplastic operations have been performed for the relief of various defects and deformities of the auricle. The excision of a V-shaped piece will sometimes prove successful in diminishing the prominence of an abnormally large auricle, but I know of no means of giving firmness to a drooping auricle—one which lacks a properly developed cartilaginous framework—unless it be by causing its posterior surface to unite with the adjacent outer surface of the head.

Frost-bite.—The auricle, by reason of its exposed position, is very apt to suffer from the effects of extreme cold. At first the cold produces contraction of the bloodvessels of the skin, but paralysis of their muscular elements soon follows, and the ear then presents a red or even purplish appearance, and is likely to be somewhat swollen. If actual freezing takes place, the ear assumes a whitish appearance, and may even, under the influence of prolonged cold, become brittle. Under favorable circumstances the frozen auricle (usually only its upper portion) may gradually resume its natural condition, though very commonly a certain degree of paresis of the bloodvessels remains, causing permanent redness of the affected part. The best method of thawing out a frozen ear is to rub it with snow at first, and then afterward with cold water. This must be done gently, as there is danger of breaking the frozen organ. When the circulation seems to have been re-established, tepid water may be used instead of cold. These procedures must be carried on either out-of-doors or in a cold room, the aim being to restore the frozen part very gradually to its proper temperature. In unfavorable cases—those, for example, in which the ear has been allowed to remain for too long a time in a frozen condition, or in which no precautions have been taken to secure its gradual restoration to a normal temperature—inflammation sets in, and, according to its severity, we may have as a final result either gangrene and sloughing away of the part affected, or a perichondritis, presenting the picture of a well-marked othæmatoma. The treatment required for the first of these conditions is amputation of the gangrenous portion; that required for the perichondritis has been already set forth on a preceding page.

As one of the sequelæ requiring surgical interference, I may mention the persistence of small, deeply excavated, sluggish ulcers, covered with hard, dry crusts. The favorite seat of these ulcers is on the upper part of the helix, or occasionally on the antihelix (see Fig. 889). It is not an easy matter to effect a genuine healing of these sores. The plan which I have found the most successful is this. After removing the crust, pare away with small, curved scissors, the bluish, undermined skin which surrounds the ulcer. Then either scrape the fibrous or cartilaginous floor of the ulcer with the point of the knife, or touch it lightly with nitric acid. Next fill the excavation with a pledget of cotton saturated with the compound tincture of iodine. Finally, as a means of holding the pledget in place, and of excluding the air, spread a few fibres of cotton like a network over the ulcerated area, and saturate the whole with collodion. Three or four days afterward, when the dressings are found to be loose, remove them, and re-apply cotton saturated with the compound tincture of iodine. By this mode of procedure, I have in several cases succeeded in permanently healing the chronic ulcers resulting from frost-bite.

Burns.—Severe burns of the auricle present either the picture of a decided perichondritis, or that of a localized death or gangrene, and nothing further need be said on the subject in this place. In the milder cases, the pain and soreness may be greatly mitigated by the local application of carbolated oil (ʒij of carbolic acid to ℥iij of olive oil) or carbolated vaseline. Cooling applications also afford relief.

Diseases and Injuries of the External Auditory Canal.

Impacted Cerumen.—Of all the affections of the external auditory canal, impaction of cerumen is by far the most common. This condition is apt to be developed without any special symptoms. The accumulation of cerumen takes place so gradually that the patient rarely suspects what is occurring, until he suddenly becomes more or less deaf in the affected ear, and experiences a sense of fulness on that side of the head. Sudden alternations between good and defective hearing are among the most marked symptoms of this condition.

When the affected ear is examined with the speculum and reflected light, a black or dark brown mass will be found filling the canal, and obstructing the view of the deeper parts of the ear. As impacted cerumen is very apt to be associated with catarrhal inflammation of the middle ear, it will be found desirable not to express an opinion, either with regard to the nature of the ailment or with regard to the prognosis, until the auditory canal has been cleared of all obstructions.

The question of *treatment* resolves itself practically into the question, how can the obstructing mass be removed most thoroughly, quickly, and pleasantly? In my opinion, the instrumental method of removing impacted cerumen is, in the majority of cases, the most effective and at the same time the pleasantest way, both for the patient and for the physician, of accomplishing the desired object. I must confess, however, that a certain degree of manual dexterity is absolutely essential to the proper performance of the operation. It is also probably true that, among the great body of medical practitioners, only a small minority possesses the requisite skill in the handling of delicate instruments. While therefore the removal of impacted cerumen by means of the syringe may seem to be a clumsy and oftentimes ineffectual method of attaining the object desired, no better method, adapted to general use, has yet been devised.

One of the chief reasons why syringing so often fails to wash out the mass of impacted cerumen, is this: the force of the current is spent upon the broad surface of the outer end of the plug, and tends therefore rather to drive it farther inward. The most effective plan is to direct the stream against one edge (preferably the upper edge) of the mass, in the hope of washing out a channel between the main body of the plug and the upper wall of the meatus. As soon as this has been accomplished, it will be found that the current begins to exert a *vis a tergo* upon a portion of the mass, and soon brings away fragments of considerable size.

If simple syringing with lukewarm water fails, we may employ some chemical reagent for the purpose of softening the cerumen and loosening its attachments to the walls of the canal. Bicarbonate of sodium, for example, may be used to advantage as a solvent. A few drops of a strong solution of this salt should be dropped into the meatus (the patient's head being turned well over toward the opposite side), and should be allowed to remain there for at least twenty minutes. If syringing then fails to bring away the ceruminous mass, the soda solution should be introduced a second time, and even a third, if necessary.

In the instrumental method of removing impacted cerumen, the aim is to loosen the attachments of the impacted mass by means of suitable instruments.

These may either be introduced directly into the substance of the mass, for the purpose of breaking it into fragments, or they may be passed flatwise between it and the walls of the meatus, with the view of dissecting it out as a whole, or in larger pieces. For this latter purpose, the curette will be found a most excellent instrument. Angular forceps, of delicate construction, can also scarcely be dispensed with in removing the loosened mass or its component parts. As we approach the membrana tympani, in our mining operations, the slender silver probe will be found to be of great service, as it may, with care, be employed in loosening the inner end of the ceruminous mass from its attachments to the drum-membrane, or to the anterior inferior *cul-de-sac* of the meatus. In conclusion, let me remind the reader that manipulations of this kind should not be indulged in, unless the operator possess delicacy of touch, a thorough knowledge of the topographical anatomy of the auditory canal, and properly constructed instruments.

It sometimes happens, in these cases of impacted cerumen, that a furuncle develops in the obstructed meatus, or that an acute inflammation is set up in the adjacent middle ear. In the presence of such a complication, the question arises, shall we allow the intercurrent inflammation to run its course, before we make the attempt to remove the impacted cerumen, or shall we undertake the latter operation without further delay? The pain attending either of the two combinations mentioned, is apt to be very severe, and the inflammation is generally more extensive and of a more serious character than when the auditory canal is free from obstructions. If, therefore, we can, by any means at our command, remove these obstructions at once, it is clear that this is the proper course to pursue. If the orifice of the canal is closed, through œdematous swelling of the soft parts, it will be found comparatively easy to dilate it gradually by means of Wilde's specula, or by the aid of conical mops of cotton, wound firmly around the end of a probe or cotton-holder, and smeared with vaseline. As soon as the ceruminous mass has been exposed to view, we should proceed in precisely the same manner as if the case were one of a simple nature.

FURUNCLES, OR BOILS.—The external auditory canal seems to possess a special predisposition to furuncular inflammation. Our knowledge of the causes which give rise to the disease is very scanty. An irritating discharge from the middle ear, or from the deeper parts of the meatus (as, for example, in eczema), very often leads to the formation of furuncles in the outer or cartilaginous portion of the canal. It has also been observed that the disease is often encountered in persons whose general health is not quite up to the proper standard.

Furuncles usually develop gradually. The patient first notices a little pain in the region of the ear, and, on pressing with his finger upon the parts, finds that they are slightly tender. Gradually the pain increases in severity, and the ear feels full and heavy. Deafness is not observed until the tumor reaches such a size as to close the meatus at the point involved. The motions of the jaw are apt to cause pain, and in some cases there is well-marked œdema in the neighborhood of the affected ear. Rupture of the abscess may take place spontaneously as early as on the second day, but as a rule we must not look for this event before the third or fourth day.

The *prognosis* is decidedly favorable. The disease shows no tendency to extend inward, in the direction of the middle ear, and it is only in quite rare cases that the abscess, instead of breaking into the external auditory canal, burrows downward and forward in the direction of the parotid gland, or backward and downward in the direction of the soft parts lying below the mastoid process.

Treatment.—If it be admitted that neither the patient's life nor his hearing power is threatened, the chief indication will clearly be to relieve his suffering. It is a disputed point how this may best be accomplished. Some of the highest authorities unhesitatingly advise the early employment of the knife. My own experience, however, leads me to adopt the rule laid down by Wilde: "As soon as we believe matter has formed and come some way to the surface, but not till then, we should make an incision." I prefer, as a rule, to wait and let the abscess open by natural processes; and, as a means of hastening these, and also for the purpose of mitigating the patient's suffering in the mean time, I am in the habit of prescribing hot poultices. These should be of sufficient size to cover the entire region of the ear (say 5 or 6 inches square), and they should be renewed at frequent intervals. While the flaxseed-meal poultice is perhaps the best that can be used for this purpose, there are various substitutes which will be found to answer almost equally well: for example, a rubber-bag filled with hot water, a flannel or muslin pillow filled with dried hops and heated in the oven or in front of a hot open-grate fire, hot bran bags, a large sponge or several thicknesses of flannel wrung out of hot water, and so on.

I have very little faith in the local use of anodynes, and the introduction of glycerine, sweet-oil, or almond-oil, commends itself still less to my judgment. Glycerine is by no means a bland and soothing fluid, and the oils may furnish a nidus for the subsequent development of the *penicilium glaucum*, or some other variety of fungous growth, which the surgeon may find it difficult to dislodge. Vaseline, on the other hand, may be used with impunity in the ear.

Local blood-letting by means of leeches is very apt to fail in this form of disease, and I do not often resort to its use if I am sure of my diagnosis. In acute affections of the middle ear it is a much more valuable remedy.

If the knife be employed, the best pattern for this special purpose is a curved, sharp-pointed bistoury. If the swelling is well defined, the incision should be made through the centre of it, the point of the knife being carried from within outward. The operation should be performed under illumination from the forehead-mirror, and the incision should be made of such a length and depth as will afford a free exit to the pus. If the swelling is not well defined, my plan is to introduce a cotton-holder, well protected with cotton, into the swollen canal, and then to exert pressure in different directions. The region of greatest tenderness is that into which I make the incision. It is well to have at hand a large sponge and a basin filled with hot water. Immediately after the incision has been made, the hot and moist sponge should be held against the ear, for the purpose of quieting the pain, which for a few minutes is generally very acute. When the pain subsides, dry warmth may be substituted for the hot and moist application. The only objection to the prolonged use of moist heat under these circumstances is, that it favors the development of granulation-tissue in the wound, and is also apt to set up a painful inflammation of the auricle.

Diffuse Inflammation.—Under the head of "diffuse inflammation of the external auditory canal," may be grouped the different pathological conditions to which the names "otitis externa diffusa," "periostitis," "eczema," "desquamative inflammation," and "otomycosis," or "parasitic disease of the external auditory canal," are commonly applied. It is not always easy to separate these different conditions, and to apply to them their proper distinguishing terms. In fact, it is only in a few typical cases that a distinct line of separation can be drawn. Furthermore, no great scientific or practical gain is effected by the establishment of these subdivisions, and I may therefore be allowed to include all under the single head of diffuse inflammation.

A simple diffuse inflammation of the osseous portion of the meatus externus, may be set up by the presence of some irritating substance or fluid in the canal. For example, salt water may produce such an inflammation ; and so may the irritating discharge from an inflamed middle ear. Among the internal or constitutional causes may be mentioned a predisposition to eczema (rheumatic ? gouty ?). An inflammation of the medullary spaces or of the air-cells of the surrounding bone, may give rise secondarily to a diffuse otitis externa. Direct violence is also not a rare cause of this form of disease.

The physical characteristics of a diffuse inflammation of the external auditory canal are, at first, a general redness and swelling of the osseous portion. The membrana tympani almost invariably participates in the inflammation, though sometimes only to a very slight degree. At a later stage of the affection, an exudation of a thin, serous fluid will be found to have taken place from these red and swollen surfaces, and at a still later period the discharge will be found to contain small white flakes, or even large white sheets, representing the cast-off, uppermost layers of epithelium. Eventually, ulceration may take place.

In those cases in which a vegetable parasitic growth develops in the inflamed meatus, this phenomenon, it seems to me, should not be considered in the light of a primary and independent disease, but rather as an accidental complication. The moisture supplied by the inflammatory exudation, the absence of a current which might wash away the germs, the presence of decomposing organic matters in the secretion, and probably also the darkness, furnish conditions which are favorable to the further development and multiplication of the vegetable germs which at all times fill the air, and which must therefore at all times be in the cavity of the external auditory canal. The appearance presented to the eye, in a typical case, is that of a meatus thinly or thickly covered with a fuzzy, white material which looks very much like cotton-wool. Black specks (*aspergillus nigricans*) are often scattered over the white ground, and sometimes this variety of the fungus predominates over the white or yellow variety.

The subjective symptoms of an otitis externa diffusa are, first, a sense of fulness in the affected ear, rarely amounting to actual pain ; second, more or less diminution of the power of hearing ; and, third, an itching sensation in the canal. In those cases which seem to be distinctively eczematous in character, this last symptom is sometimes extremely distressing.

The red, swollen, and perhaps moist condition of the parts, enables the observer to say positively that a diffuse inflammation of the external auditory canal exists, but it is not so easy a matter to determine whether this inflammation is primary in its nature, or merely secondary to an affection of the middle ear. We must test the hearing, examine the condition of the naso-pharyngeal mucous membrane, and ascertain, by auscultation during the act of inflation, the condition of the middle ear and Eustachian tube. If there is comparatively little disturbance of the hearing, if there is no evidence of an acute naso-pharyngeal catarrh, and if the air enters the tympanic cavity freely and without *râles* or crackling sounds, we are fairly justified in pronouncing the disease an acute, primary, diffuse inflammation of the external auditory canal.

The presence of aspergillus can only be determined positively by placing some of the suspected products under the microscope, and demonstrating the presence of the stalks, and perhaps also of the fruit, of the parasitic plant.

The different forms of diffuse inflammation of the auditory canal have very little tendency to damage the hearing, and apparently none whatever to spread toward the middle ear or mastoid cells. By direct extension, they may excite a subacute mastoid periostitis. They are very apt also to occasion, or to be associated with, furuncles of the cartilaginous portion of the canal. In the acute cases, the prospects of an early and complete cure are good; in the chronic ones, our prognosis must be guarded, as the disease is at times exceedingly stubborn, and relapses are very common.

The *treatment* must vary according to the stage or condition in which the disease happens to be. If the parts are simply red and swollen, and have not yet begun to secrete, a small blister over the mastoid process may be found sufficient to check the further progress of the disease. If the walls of the canal are already moistened by secretion, nitrate of silver in solution is to be employed. Before the solution is instilled into the meatus, it is very important to clean the inflamed parts thoroughly, so that they may be exposed to the full action of the remedy. The physician should therefore carry out this part of the treatment himself. Before the solution is introduced into the canal, the syringe and a vessel of warm water should be placed within easy reach. After the solution has been dropped into the canal, the physician should wait until the patient experiences a distinct sensation of warmth, pain, or throbbing in the ear. I always request the patient beforehand to direct his attention to the ear, and to inform me as soon as he perceives either of the sensations just mentioned. With a solution of from forty to sixty grains to the ounce, the sensation of warmth will generally not be felt by the patient until after the lapse of three or four minutes; with a solution of double that strength, the sensation is usually experienced much sooner. As soon as decided warmth, throbbing, or pain is felt by the patient, the remedy should be washed out of the canal by means of the syringe and tepid water. The walls of the meatus must then be dried carefully by means of the cotton-holder armed with absorbent cotton, and when properly dried they should be anointed with simple vaseline, or with vaseline to which a little oil of cade has been added. Very often a single such slight cauterization of the canal suffices to arrest the disease. In other cases two or three repetitions will be found necessary. These should be made at intervals of two or three days, and if the discharge from the ear is active, the patient should be instructed to wash out the canal with the syringe or douche once or twice a day. Otherwise the ear may be left alone from one visit to the next.

In the more distinctively desquamative cases, the treatment must be slightly modified. In the first place, a thorough removal of the firmly attached laminæ of dead skin can scarcely be effected without the aid of the curette. This instrument, inserted flatwise between the dead and the living skin, may be used very effectively in dissecting off the former. The forceps then comes into play, or, if it be preferred, the syringe may be used for the purpose of removing the fragments or sheets of dead skin that have been separated from their attachments. Lately I have occasionally used liquid potassa soap in freeing the canal from these masses, and have found it very efficacious. When the walls of the canal have thus been carefully freed from all foreign matters, and, as it were, laid bare, we may proceed to the instillation of the silver solution. Furthermore, in this class of cases, it is important that the patient should keep the auditory canal, throughout its entire length, well anointed with the oil of cade and vaseline mixture, or with simple "cuticura."[1] At least twice a day he should make these applications to the canal.

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[1] "Cuticura" belongs to the class of patent medicines, and bears a strong resemblance to vaseline. It differs from the latter, however, in one very important respect: it retains its semi-

Ulcers, Polypoid Growths, and Bone-Caries.—In the great majority of cases, the pathological conditions enumerated in the above title are encountered only as secondary phenomena, dependent upon a primary inflammation of the middle ear. In a few cases, however, they present all the appearances of being purely independent affections. If the true history were known in each such instance, it would probably be found that the primary affection had healed, leaving the secondary pathological process as the only evidence of active disease.

Cases of this kind are by no means common. They are interesting as pathological curiosities; but, as they do not differ, in any important respect, from the same lesions of a clearly secondary nature, I may be allowed to omit any further mention of them in this place.

Syphilitic Ulcers and Condylomata.—Well-marked syphilitic lesions, such as ulcers, gummy spots or tumors, and papillary growths, are rarely seen in the external auditory canal. They are to be treated in precisely the same manner as these lesions in other parts of the body are usually treated, viz., by the internal administration of some mercurial preparation, or iodide of potassium, and locally by cauterization or excision.

Foreign Bodies in the Auditory Meatus.—Under this heading are included all objects, or living organisms, which find an entrance into the external auditory canal from without, and not those which have developed in that cavity, or originally formed a part of its walls. They consist usually of such articles as a child is in the habit of playing with; as, for example, glass beads, small pebbles, bits of slate pencil, peas, beans of different varieties, cherry and prune pits, etc. Insects and bugs of various kinds also sometimes find their way into the meatus.

As a rule, the foreign body causes very little, if any, discomfort, and the patient is usually brought to the physician's office, more on account of the fear, on the part of the parents, that damage may be done to the ear if the foreign body be allowed to remain, than on account of pain or any marked impairment of the hearing observable at the time. When pain is a noticeable feature of the case, it will usually be found, on inquiry, that unskilled attempts have been made—in some instances by friends, in others, I regret to say, by medical men—to extract the foreign body. Cases have even been known in which persistent and violent attempts were made to extract a foreign body whose presence in the ear was purely imaginary.

It is, therefore, the physician's first duty, when consulted about a case of foreign body in the ear, to ascertain by direct inspection whether the object in question really is, or is not, present in the external auditory canal. When he has seen the foreign body, he should proceed to ascertain, by careful exploration with the curette or the slender middle-ear probe, whether it lies loosely, or is firmly impacted in the canal. The anterior *cul-de-sac*, which is situated between the membrana tympani and the anterior inferior wall of the meatus, is sometimes quite a deep recess, and may then readily harbor a small foreign body so perfectly that simple inspection will fail to discover the fact of its presence in the canal. If we have reason, therefore, to believe

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solid, ointment-like consistence at the ordinary temperature of the human body, whereas vaseline at the same temperature speedily becomes almost as fluid as water. The composition of cuticura is unknown to me, but I have now used it for more than a year in cases of inflammation (eczematous or otherwise) of the external auditory canal, and can speak with confidence of its beneficial effects. I do not believe that its curative powers reside in anything that is peculiar to the preparation as a drug or chemical compound; they are due entirely, I believe, to the prolonged protection which it is capable of affording against the injurious effects of exposure to the air.

that the foreign body may be concealed in this pocket, we must bend the end of the middle-ear probe slightly, pass it gently down to the inner end of the canal, and then sweep the tip of the instrument cautiously along the bottom of the *cul-de-sac*, in order to bring the foreign body into view, if it be lodged in that locality. Again, I suppose I must repeat the caution, that only those who who are able to see the membrana tympani distinctly, and who at the same time possess the requisite degree of delicacy in their manipulations, have any right to attempt the removal of such a foreign body by means of probes or hooks. All others should rest satisfied with the comparatively safe method of syringing the ear which is believed to harbor the foreign body. In this connection I desire to make the remark, that a failure to bring to light an object that is supposed to be lodged in the external auditory canal, by means of syringing, affords but a very poor guarantee that the canal is free from the presence of any such foreign body. Furthermore, there are occasions when the employment of the syringe may do positive harm ; as for instance, when the foreign body is a dried bean or pea, which, under the influence of moisture, may swell up to twice the size which it possessed in the dry state. In the case of larger foreign bodies, which are actually impacted in the meatus, instrumental interference, by means of long and slender hooks of different sizes, becomes almost a necessity. Under such circumstances syringing is reasonably sure to fail, and, if such proves to be the case, the physician should frankly confess his inability to extract the foreign body, and should obtain the assistance of an expert. If the patient is free from pain, and there are good reasons for believing that the foreign body is not exciting inflammation of the surrounding parts, it will be perfectly proper to postpone surgical interference for several days, or even weeks, if necessary. The reasons why the foreign body should be removed, are these. It may change its position and assume one in which it will press against the membrana tympani; in the event of an acute inflammation of the middle ear, it may prevent the free escape of the discharge from the drum-cavity, and thus favor the development of serious intracranial disease (abscess or simple meningitis); and, finally, its presence in the auditory canal is almost invariably a source of great anxiety to the parents, and its removal is therefore likely to produce correspondingly great satisfaction.

In removing a loosely-fitting foreign body from the auditory canal, no difficulty will be experienced in passing a bent slender probe, or a slender steel hook, by the side of the object, between it and the wall of the meatus, and then turning the instrument on its long axis in such a manner as to bring the bent part of the hook directly behind the body. By cautiously pulling upon the instrument we may then readily extract the foreign substance. In the case of a tightly fitting object, we should proceed in precisely the same manner. The task, however, will be found far more difficult, and we may find it necessary to re-adjust the hook several times, before we finally succeed in dislodging the foreign body. All these manipulations, it must be clearly understood, are to be made only when the auditory canal is perfectly illuminated, and while the operator is observing as closely as he can the direction in which his instrument is travelling, and the depth to which he has made it penetrate.

The after-treatment in the more serious cases should be essentially the same as that which is required in cases of acute inflammation of the external auditory canal or middle ear. In the simpler cases no after-treatment is necessary.

Wounds of the Auditory Meatus.—Wounds involving only the external auditory canal are in my experience quite rare. They usually result from the introduction, into the meatus, of some sharp-pointed object against which a blow is received. These lacerated wounds of the auditory canal, or rather of the cartilaginous portion of the canal, present only one feature of special interest: I refer to the persistent bleeding which so frequently characterizes them. This symptom is undoubtedly to be attributed to the fact that those bloodvessels which pierce the cartilaginous framework, as many of them do, are not capable of contracting and retracting beyond a very limited extent; their physical relations being essentially the same as those of the bloodvessels which traverse bony structures.

The question of treatment calls for no special remark.

New Growths.—The commonest form of new growth in the external auditory canal is the *osteoma.* It is encountered both in the form of an exostosis and in that of a more diffuse hyperostosis. The latter variety is more frequent than the former. In many cases, the development of new bone is clearly dependent upon inflammatory disturbances in the skin of the osseous portion of the canal, which is at the same time a periosteum, but in others no satisfactory explanation of the cause can be given. On an examination of the meatus with the speculum and reflected light, the picture presented to the eye of the observer is either that of a smooth, but very much contracted canal, or of one from some portion of which a hemispherical, broad-based, and very smooth mass, or one with a more or less well-defined neck, projects. The necessity to operate upon an exostosis may arise, as it appears to me, only under two conditions —viz., when, by its encroachment upon the calibre of the meatus, the tumor seriously diminishes the power of hearing (the other ear being, at the same time, either totally or markedly deaf), or when, by its damming up a discharge from the middle ear, it threatens to superinduce serious disease of the brain or other adjacent organs. In the latter event, the establishment of a counter-opening in the mastoid process may be found an easier, and yet equally effective, means of affording an outlet for the pent-up matter.

Primary *carcinoma* of the external auditory canal is exceedingly rare, and furthermore, in the few published records of cases, it is not made wholly clear that the tumor did not develop primarily in some neighboring region.

Sarcoma is also very rare as a primary growth in this region of the ear.

Cysts, with fluid or semi-solid contents, are occasionally encountered in the auditory canal. Those with fluid contents in the vicinity of the drum-membrane are, I might almost say, always secondary to some affection of the middle ear. In some instances, however, the primary disease recedes so completely, that the cyst-like formation in the meatus gains proportionally in individuality, and may even be taken for a tumor of primary development. As the description of these secondary cysts belongs more properly under the heading of diseases of the middle ear, I will say nothing further on the subject in the present section.

Methods of Examining the Middle Ear.

The cavity of the middle ear is open to direct inspection only when, through disease, a large portion of the drum-membrane has been destroyed. Under other circumstances, we are obliged to infer what the condition of this cavity is, from a variety of data, such as the degree of acuteness of the hearing, the appearances presented by the drum-membrane, both before and after air has been forced into the tympanum, the character of the sounds heard through an auscultation tube during the performance of this operation, the condition of the integuments covering the mastoid process, the state of the naso-pharyngeal mucous membrane, the results obtained with the tuning-fork test, the subjective symptoms as described by the patient, etc. Of all these data, the most valuable is unquestionably the appearance presented by the membrana tympani. A perfectly normal condition of the tympanic mucous membrane, and a perfect condition of the function of hearing, are scarcely possible, unless the membrana tympani is subjected to the same degree of atmospheric pressure on both sides. To maintain such a condition of equilibrium between the inner and the outer atmospheric pressure, Nature has constructed the Eustachian tube, or the channel of communication between the middle ear and the throat, in such a way that the air can readily pass through it, to and from the cavity of the tympanum. When this channel becomes obstructed by mucus, or closed through the swollen state of its walls, the condition of equilibrium ceases to exist; for the air confined in the middle ear rapidly becomes rarefied through absorption, and, as a result, the greater pressure upon the outer surface of the drum-membrane forces it inward beyond the position which it occupied when pressure and counter-pressure were exactly equal. The degree of patency of the Eustachian tube may therefore be estimated with considerable accuracy by a careful inspection of the drum-membrane. A slight diminution in the perviousness of the tube to air, will show itself in a shortening of the triangular "bright spot," which should extend from the immediate neighborhood of the "umbo," or tip-end of the handle of the hammer, nearly to the periphery of the membrane; in a change in the outer surface of the membrane, which, instead of the form of a shallow cone, assumes that of a saucer, or segment of a hollow sphere; and, finally, in some cases, in an increased transparency of the membrane. Only a practised eye can note changes of such a very slight degree. In the more marked cases of tubal obstruction, the "bright spot" will be found indeed to be a mere spot in the central part of the membrane, in front of the "umbo;" the unnatural concavity of the membrane will be readily recognized by even an unpractised eye; and its transparency may be so great as to delude even an expert into the belief that he is looking directly into a middle ear which has been deprived of its membrana tympani. This peculiar transparency of the membrane may be lacking; and in that event our attention will probably be attracted by other equally striking changes in the relations of the parts. I refer to the marked prominence of the short process of the hammer, to the sunken condition of the soft parts (*membrana flaccida*) immediately surrounding this bony prominence, to the sharply-defined outlines of the posterior fold, to the foreshortening of the handle of the hammer, and to its apparent nearness to and parallelism with the posterior margin of the membrana tympani.

Inspection of the membrana tympani, when illuminated by reflected light, reveals to us still other conditions of this membrane and of the adjacent tympanic cavity. Thus, for example, we may learn the degree of vascularity and œdematous infiltration of these parts, the amount of free fluid contained within the tympanum, the presence of an excessive quantity of air in the middle ear, and many other less important changes in the condition of nutrition of these parts. The value of inspection may be greatly enhanced, in many cases, by the employment of certain collateral procedures, such as inflation of the middle ear by either Valsalva's or Politzer's method, the inclination of the patient's head either backward or forward, the careful manipulation or exploration of the parts with a slender probe or curette, and the exhaustion of the air in the external auditory canal. This latter procedure is carried out by means of what is known as Siegle's pneumatic speculum. This instrument consists of a central cylindrical chamber, of either metal or hard rubber, to which is attached a flexible rubber tube about a foot in length. To one end of the chamber, which is a little over three centimetres in diameter, a conical speculum is fitted; the opposite end is closed by a glass window placed at such an inclination to the axis of the cylinder, that the rays of light used for illuminating the drum-membrane may readily pass through it without any portion of them being reflected back to the eye of the observer. The free end of the speculum is sheathed with rubber tubing, and may therefore be made to fit air-tight into the auditory canal. When the instrument is in actual use, the observer, by holding the free end of the rubber tube in his mouth, has it in his power to condense or rarefy the air in the auditory canal, and, while doing so, to watch the effects of these procedures upon the drum-membrane and handle of the hammer.

The remaining methods of studying the condition of the middle ear, derive their value chiefly from the facts which may be learned by auscultation combined with the forcible introduction of air into this part, by way of the Eustachian tube. There are three such methods, viz., Valsalva's, Politzer's, and that by means of the Eustachian catheter.

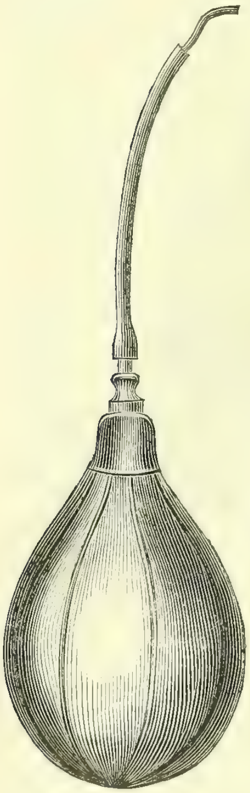
In inflating the middle ear by *Valsalva's method*, the patient closes both nostrils by grasping the nose with the thumb and forefinger of one hand, shuts his mouth firmly, and then makes a strong expiratory effort. In this way he compresses the air in the pharyngeal and nasal cavities to such an extent that it seeks an outlet through the Eustachian tubes. If the effort is successful, the surgeon, who has previously established a communication between his own ear and that of the patient, by means of a flexible auscultation-tube, will hear a slight puff or thud, as the air enters the middle ear and distends the drum-membrane. Of the three methods at our command, this is the most unsatisfactory for the purposes of auscultation, but decidedly the best when we desire to watch the changes that may take place in the drum-membrane while air is being forced into the middle ear. For therapeutic purposes, on the other hand, it is decidedly inferior to either of the other two, chiefly because it is associated with an undesirable, if not dangerous, degree of venous congestion about the head and neck. In Valsalva's method the introduction of air into the middle ears is not facilitated by the act of swallowing, which is an essential feature of Politzer's plan.

Politzer's method of inflating the middle ear is very little better, for auscultatory purposes, than that of Valsalva, unless the surgeon can avail himself of the services of an assistant. If he attempt to inflate and auscultate at the same time, he will find the task an extremely difficult one, at least in adult patients. In children, so little force is required to inflate the middle ear, that one can often perform both acts at the same time in a very satisfactory manner.

The apparatus which is usually employed in carrying out Politzer's method consists of a rubber bag, provided at one end with a hard-rubber nozzle; of a short piece of soft-rubber tubing, of rather small calibre, but of comparatively thick and unyielding walls; and lastly, of either a curved, cylindrical, or a bulbous, hard-rubber nose-piece. In adults, the curved, hard-rubber nose-piece, like that represented in the accompanying cut (Fig. 891), will be found entirely satisfactory in the majority of cases. In children under four or five years of age, in whom the nasal orifice is quite small and tender, a nose-piece consisting of a spherical or cone-shaped hard-rubber, or, still better, glass bulb, will usually be found preferable to the cylindrical one.

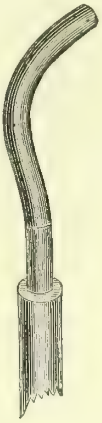
The mode of procedure, in Politzer's method, is as follows: The patient should take a little water—a few drops will suffice—into the mouth, and then, when the proper signal is given, he should swallow the water, while keeping his lips closed. The physician, on his part, should hold the rubber bag in his right hand, and, when the patient has taken the water into his mouth, he should introduce the nose-piece a distance of about half an inch into his left nasal orifice, using, if necessary, his left hand to aid him in placing the instrument in its proper position on the floor of the nasal passage. As soon as he has accomplished this, he should at once compress the nostrils firmly over the rubber nose-piece, and give the patient the signal to swallow the water. The act of compressing the bag and forcing air into the nasal cavities should follow the signal almost instantly. With very deaf persons, a nod of the head or a nudge with the knee will serve as a signal; but in the majority of cases it is customary to give the command, Swallow! With children, it is often sufficient to simply instruct the child to keep the mouth tightly closed, or to inflate the cheeks, at the moment when we are ready to compress the rubber bag. These devices, however, and some others which lack of space will not permit me to describe, are inferior to the original Politzer's method in one important particular, viz., they do not take advantage of the great assistance afforded by the act of swallowing in separating the lips of the tubal orifices, and thus rendering the tubes themselves more easily pervious to air, at least for the brief moment of time consumed by this act.

Fig. 890.



Politzer's apparatus.

Fig. 891.



Hard-rubber, curved nose-piece. Full size.

In this connection I should call attention to the fact that harm may sometimes be done to the ear by the careless or injudicious use of Politzer's method of inflation. The operation should never be resorted to until after both drum-membranes have been examined. The conditions which contraindicate sudden and forcible inflation of the middle ears, are these: a highly sunken drum-membrane, which may possibly also be adherent to some of the deeper parts of the middle ear; a decidedly atrophied drum-membrane, or one in which a very thin cicatrix exists; and, finally, an acutely inflamed drum-membrane. In all of these conditions it is best to employ inflation, at first, in a cautious manner, or even—as, for instance, when there is active inflammation of the middle ear—to abstain entirely from using it.

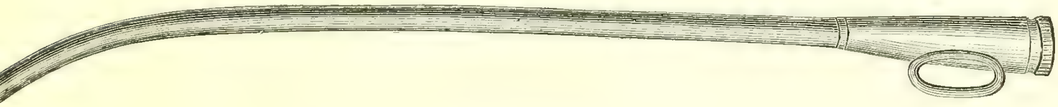
The third method of inflating the middle ear is that by means of the *Eustachian catheter.* When this instrument is used, the air passes through the Eustachian tube into the middle ear in a continuous current of one or two seconds' duration. This steadiness and long duration of the current afford the physician ample opportunity to listen deliberately to the character of the sounds which it produces. For purposes of diagnosis, therefore, this method possesses a decided superiority over the other two.

The instruments required for the operation of catheterizing the Eustachian tube, are a suitable catheter, either of hard rubber or of metal, an auscultation-tube, and a soft-rubber bag with a nozzle that can be applied to the mouth of the catheter in such a manner as to close it. A well-made hard-rubber catheter is an excellent instrument, and leaves very little to be desired. It is a very difficult matter, however, to obtain such a well-made catheter.

The calibre of the instrument is rarely as large as it should be, or else, if the calibre is sufficiently large, the total diameter of the instrument is so great that it can be used only in exceptional cases. A good, serviceable Eustachian catheter should have a calibre of about two and one-fourth, or two and one-half millimetres, and a total diameter of not more than three and one-half millimetres. This proportion of calibre to total diameter is scarcely attainable in an instrument made of hard rubber. The largest rubber catheter that can ordinarily be bought in the shops, measures nearly four and one-half millimetres in its total diameter, while its calibre measures only two millimetres. For the majority of nasal passages this instrument is too large, and yet its calibre is barely large enough to allow a current of air to be driven through the instrument into the Eustachian tube with the requisite degree of force. On the whole, therefore, the silver catheter, if made of coin metal and properly proportioned, will be found to give the greatest satisfaction. At the same time, it must not be forgotten that many of the silver catheters sold in the shops are even less serviceable than those made of hard rubber. The calibre is not one whit larger, in proportion to the total diameter, than that of the average hard-rubber catheter; and, furthermore, the edges of the beak of the instrument are often so sharp as to cause the patient pain, either during its passage through the nose, or while it lies in the mouth of the Eustachian tube.

With regard to the curve which a good Eustachian catheter should have, I may say that the one represented in the accompanying cut is that which I have found suited to the great majority of adult patients. Some of my colleagues use a straighter instrument, and others, one of even greater curvature; from which it is proper to draw the conclusion that the middle ear may be successfully inflated by variously curved catheters. To secure the most effective inflation, however, we should give the catheter such a curve that, when it is in position and air is forced through it, the direction of the escaping current may be the same as that of the Eustachian tube itself. The common error, as far as my observation goes, is to give the instrument a curve of too short a radius, which causes a large part of the force of the current of air to spend itself upon the upper wall of the Eustachian tube. In children from five to about twelve years of age, it will be found better to use a catheter that is even less curved than that represented in the cut; or one, at all events, in which the curve begins at a point considerably nearer the free end than it does in this instrument.

Fig. 892.



Eustachian catheter, of silver; full size.

In my work on Diseases of the Ear, I have given a detailed description of the different steps of the procedure of introducing the Eustachian catheter, and I will essentially reproduce it here. The surgeon should sit directly facing the patient, and at his right hand, within easy reach, should be his rubber bag, auscultation-tube, and a bowl or goblet partially filled with water, and containing five or six catheters of different sizes and degrees of curvature. He should have his forehead-mirror in position, ready for use, as he may at the very beginning find it desirable to examine, under illumination by reflected light, the patient's anterior nares. Everything being in readiness, and the water having been shaken or blown out of the catheter, the operator should place the fingers of his left hand firmly upon the patient's forehead, and, with the end of his thumb, he should elevate as much as possible the end of the patient's nose—the object of the latter procedure being to straighten the entrance to the nasal passage, and in so far to facilitate the introduction of the catheter. This instrument should be held lightly by the surgeon, between the thumb and forefinger of his right hand, and at no time should force be used in overcoming any obstacles that may be encountered. Just within the nasal orifice, the floor of the nasal passage rises up in the form of a ridge, the inner or deeper side of which is more abrupt than the outer one. When the catheter is first introduced into the nasal orifice, its outer end should be at a somewhat lower level, though in some cases we may begin at once with the instrument in a nearly horizontal position. To pass it beyond the ridge, and engage it in the lower nasal passage, the surgeon must elevate the ring end of the instrument until it occupies a nearly horizontal position. It is at this stage of the operation that the beginner is very apt to make a mistake. Instead of passing the catheter along the floor of the nasal canal, he slips it over the upper surface of the inferior turbinated bone, and, on reaching the naso-pharyngeal space, wonders why his efforts to turn the instrument into the mouth of the Eustachian tube cause the patient such great distress. A glance at the illustrations of this region, in some good treatise on anatomy, will show how easy it is to make this mistake. It is only necessary to push the beak of the instrument a short distance beyond the summit of the ridge, and we shall find it slipping only too easily along the wrong channel. When the catheter has been pushed beyond the ridge, and is actually resting upon the inferior turbinated bone, the elevation of the ring end of the instrument will not correct the error unless the catheter be withdrawn a certain distance. In the first stage of the operation, therefore, it is important to hug the floor of the nasal passage with the beak of the catheter, at least until the instrument has passed beneath the inferior turbinated bone, and is well engaged in the lower channel. As already stated, it is better, from this point onward, to let the instrument find its own way. By this I mean that if the catheter encounters some obstacle, we should abandon the attempt to push it onward in a certain fixed manner—that is, with the beak always pointing downward and backward—and should rotate the instrument slowly, while keeping up a gentle pressure from behind, until we find a position in which it no longer encounters opposition, but yields to the pressure which tends to drive it farther inward toward the naso-pharynx.

As we wish the instrument, on first reaching the cavity, to lie with its beak turned directly downward, we should begin at once, after passing the obstacle referred to, to rotate the catheter back toward the desired position. If we fail in our efforts to overcome the obstacle encountered, we must either resort to an instrument of smaller diameter, or try to reach the Eustachian tube by way of the nasal passage of the opposite side. The latter course will usually be found the preferable one. When the catheter is in the naso-pharyngeal space, with its beak turned directly downward, we should first make sure of our bearings by pushing the instrument onward until we feel the resistance offered by the posterior pharyngeal wall. When the catheter is in this position, we know that if we rotate it far enough we shall carry the beak into what is known as Rosenmüller's fossa, a slight depression located just behind the mouth of the Eustachian tube. Hence, if we wish to introduce the instrument into the latter cavity, we must draw it out a distance of a quarter or three-eighths of an inch, and then rotate it through an arc of about one hundred and thirty-five degrees, or until a line drawn through the plane of the ring attached to the catheter passes through the outer angle of the patient's eye. If we rotate the beak of the catheter first into Rosenmüller's fossa, and then draw it out a short distance, we can often feel the end of the instrument pass over the rounded eminence which constitutes the inner lip of the mouth of the Eustachian tube. As the distance of the tubal orifice from the posterior pharyngeal wall varies in different individuals, the method last described, of guiding our movements by aid of the sense of touch, rather than by rough estimates of distance, is the one to which most aurists, I think, give the preference. In some individuals, the landmark which I have just described is so feebly developed, or the surrounding parts are so swollen, that the operator feels doubtful whether he has reached the mouth of the tube or not. In such cases the Giampetro-Löwenberg method will be found useful. According to this method, the catheter is to be rotated toward the Eustachian tube of the opposite side, and when its beak occupies a horizontal position, as indicated by the metal ring, the instrument is to be drawn out until the resistance of the posterior edge of the nasal septum is encountered. The catheter is then to be rotated in the opposite direction, through an arc of at least one hundred and eighty degrees, into the mouth of the Eustachian tube which it is desired to reach. In all three methods, but especially in the one last described, the surgeon will do well to grasp the body of the catheter with the thumb and forefinger of his left hand before he performs the act of rotation with his right hand. In any event he will have to grasp it in this manner after the instrument finally reaches its proper position, as the right hand will be required for other purposes. The support thus afforded to the catheter is a very firm one, as the last three fingers of the left hand find a strong resting-place on the bridge of the patient's nose, or on the lower part of his forehead. As long as the operator's fingers press firmly against the patient's skull, he need have very little fear of the disturbing influence of a sudden motion of the patient's head upon the position of the catheter.

When the surgeon believes that the beak of the instrument is lying in the mouth of the Eustachian tube, he should give the patient one end of the auscultation-tube to place in the meatus of the corresponding ear, and should fix the other end tightly in his own auditory canal, preferably the left one. With his right hand he should then grasp the rubber bag (the ordinary Politzer's bag will answer well for this purpose) and apply the hard-rubber nozzle of the instrument to the mouth of the Eustachian catheter. If the latter instrument is in the right position, and the Eustachian tube is not unnaturally contracted, he will hear the air streaming as it were into his own ear. If the catheter, however, occupies a wrong position, he will probably still hear the air streaming out of the end of the instrument, but it will no longer seem to be escaping into his own ear; the sound will appear to be more distant and less distinct.

In withdrawing the catheter from the nasal cavities, no special precautions are necessary. The instrument is first to be rotated back to its original position, with the beak pointing downward, and then it is to be drawn out gently from the nose.

Great stress is laid, in some treatises on practical otology, on the danger of causing emphysema of the cellular tissue in various parts of the neck, but particularly in the region surrounding the entrance to the air-passages, in the course of the operation of forcing air into the middle ear by means of the Eustachian catheter. I must confess that I have never seen an instance of this accident, nor have I heard of its occurrence in the practice of any of my colleagues here in New York. I can easily understand, however, that the employment of a catheter with a sharp-edged beak, or the use of too much force in getting the instrument into its proper position, might lacerate the mucous membrane at the mouth of the tube, and so open the way for the production of an emphysema of even wide extent.

Diseases of the Middle Ear.

Non-suppurative Inflammation or Simple Catarrh. — By the term "catarrh of the middle ear," as used in this article, and very generally by American surgeons, is meant a type of inflammation of the mucous membrane of the Eustachian tube, tympanum, and communicating pneumatic spaces, which is characterized by redness, swelling, and increased secretion of the parts, and which stops short of ulceration and perforation of the membrana tympani. When the affection is of recent date, and subsides in the course of a few days or weeks, we speak of it as an "acute catarrh of the middle ear" (*otitis media catarrhalis acuta*). When the history given by the patient shows that the pathological process has been going on for months, and perhaps even years, we may properly designate the affection as a "chronic catarrh of the middle ear" (*otitis media catarrhalis chronica*).

An *acute catarrh of the middle ear* may manifest itself under different forms. For example, the inflammation may restrict itself almost entirely to the Eustachian tube, and the expression "Eustachian catarrh" is then very often employed. In comparatively rare instances, the inflammation displays a mild character in its course along the Eustachian and tympanic portions of the mucous membrane, and then spends its greatest force upon the mastoid portions; or the upper portions of the tympanic cavity may show evidences of an active inflammation of the mucous membrane, while the lower portions remain in almost a normal state. In fact, many cases of severe purulent inflammation of the middle ear begin, as far as I have been able to judge from simple inspection of the membrana tympani with reflected light, as a localized inflammation of the upper portions of the tympanic cavity. The prevailing type of an acute catarrh of the middle ear, however, is characterized by a more uniformly distributed congestion and swelling of the drum-membrane, and by more or less marked closure of the Eustachian tube. Sometimes both ears are equally affected, but as a rule the inflammation is much more active on one side than on the other.

An inflammation of the naso-pharyngeal mucous membrane almost invaribly precedes this variety of aural disease, and the naso-pharyngeal inflammation in its turn owes its origin to exposure to cold, or to the specific influence of the poison of smallpox, scarlet fever, or measles. In a few cases, the ear disease owes its origin directly to the entrance of an irritating fluid into the tympanic cavity, by way of the Eustachian tube, or to the irritation caused by the presence of too hot or too cold fluid in the external auditory canal.

The *symptoms* are various, and all are not always present in one and the same case, or in one and the same ear. Pain in the affected region is the most prominent symptom. It is rarely severe, and in many cases is entirely absent. Pulsation is not often felt by the patient. If present, it usually indicates that an exudation of fluid has taken place in the tympanic cavity, or that the Eustachian tube is impervious to air. Subjective noises of varying intensity and character, and resonance of one's own voice in speaking, are common symptoms. More or less marked diminution of the hearing is always present. A sensation of fulness or weight in the affected ear, is sometimes mentioned as a prominent symptom. Numbness of the affected side of the head is not a rare accompaniment of the disease, and I have known it to persist for a long time. In exceptional cases, deep pressure in front of the tragus causes pain, and the glands on the side of the neck, below the ear, are very apt to be tender and perceptibly swollen. The act of swallowing is at times accompanied by pain, or by a sense of soreness in the region of the Eustachian tube. In some cases the patient complains that loud sounds produce a painful sensation, not so much in the ear proper as in the sensorium. Certain musical tones, especially those of a comparatively high pitch, may also produce a peculiar fluttering or jarring sensation, which is felt directly in the ear, and which is very distressing. Double hearing even is observed in rare instances. Finally, in a certain proportion of the cases, free serum or mucus accumulates in the tympanic cavity, and its presence may then give rise to some very characteristic symptoms, such as a sense of something moving in the deeper parts of the ear when the head is moved, a crackling sound when the nose is blown, and a marked increase in the acuteness of the hearing when the head is held in a certain position—as a rule, that maintained by a person in the recumbent posture.

The *physical examination* follows next in order. Some impairment of the hearing of one or both ears will always be found, but it may be of very slight degree. The vibrations of the tuning-fork which rests upon the centre of the patient's forehead, will almost invariably be heard loudest in the ear most affected. I have, in a few instances, met with the reversed state of things, and have been puzzled to find a plausible explanation of the phenomenon. That given on page 290 is the only one that I can offer. We must remember, however, that while a temporary participation of the labyrinthine vessels in the inflammation, leading to diminished perceptive power of the auditory nerve of the side affected, will perhaps serve as an explanation for some of these cases; in others, it is quite possible that the phenomenon may be due to the existence, in the apparently well ear, of some changes in the structure or tension of the apparatus of hearing, of so slight a degree that we are unable to measure them, but yet sufficiently marked to produce the discrepancy referred to above, viz., that of referring the sound of the vibrating tuning-fork to the good ear. As a matter of course, the presence of a mass of cerumen or of a plug of cotton in the presumably well ear, will destroy the value of the tuning-fork test.

The drum-membrane of an ear which is the seat of an acute catarrhal inflammation of the middle ear, may be expected to show, in the earlier stages of the disease, evidences of congestion. The long process of the malleus, and the circular periphery of the membrane, are the regions in which the bloodvessels will be found gorged with blood. Sometimes the area of redness will involve the intervening parts of the drum-membrane, and occasionally even the adjacent cutaneous walls of the canal will show evidences of participation in the inflammation. The polished appearance, which is a marked feature of the normal membrana tympani, is soon succeeded by a dulness and roughness of the surface, attributable to an exudation of serum and lymphoid cells from the bloodvessels. In another class of cases, we shall find the lower part of the drum-membrane fairly normal in appearance, while the upper part, and particularly the thicker tissues constituting the posterior fold, show very decided evidences of active inflammation. In a third class, finally, the membrane, while retaining its polished surface, presents an appearance quite different from that observed in the normal drum-membrane: the tissues composing it look as if they had been soaked in oil, and the prevaling color is not the grayish slate-color of the normal membrane, but a dark purple, or even a dull greenish hue. On closer inspection, we shall find that we are looking at a very much sunken membrane, and that the peculiar color is due to the reflection of light from the very red mucous membrane of the promontory. If air still remain in the drum cavity, the tint reflected will be reddish or purple, but if a yellowish, translucent serum be present in the cavity, it will be likely to impart a greenish hue to the color. In these cases, we may confidently assume that the Eustachian tube participates very decidedly in the pathological changes, and that its permeability to air is, for the time, suspended. If the tympanum contains partly air and partly fluid, we may see the outlines of bubbles through the membrana tympani, or a delicate line corresponding to the boundary of the fluid.

Our attention should next be directed to the condition of the naso-pharyngeal region. From the patient's own statements, we shall probably already have learned that the aural symptoms developed during an attack of "cold in the head," and on direct examination of the pharyngeal mucous membrane, we shall be likely still to find evidences of the disease in this locality, viz., redness, swelling, and perhaps increased secretion. If such evidences, however, are lacking, we must not allow ourselves to draw the inference that the region which is situated higher up, and which we cannot see unless we employ a rhinoscopic mirror, is likewise free from all inflammatory irritation. In fact, we may with great positiveness assume the very reverse of this, and that too, oftentimes, despite the patient's assurance that all symptoms of the "cold in the head" have entirely disappeared. This a point on which I desire to lay particular stress, for it is one that is very often overlooked, and yet it is the very one upon which the successful treatment of this class of cases hinges.

In well-marked cases, the course of the disease will cover a period of from two to five or six weeks. Under unfavorable conditions the irritation may persist for months, and may resist our best efforts to get the mastery over it. A complete or apparently complete return of the middle ear to a normal condition, may confidently be looked for in the great majority of cases. It is only in a few of them that the acute attack proves to be the beginning of the chronic form of the disease, with its attendant symptoms—permanent diminution of the power of hearing and distressing subjective noises.

Treatment.—As I have already said, the most important feature, in the treatment of this disease, is to try and restore the naso-pharyngeal mucous membrane to a healthy condition. In my hands, nitrate of silver has proved to be the remedy by far the most effective in accomplishing this object. It is certainly a disagreeable remedy, even when properly managed; and when applied in a careless manner, it is quite sure to produce nausea or headache, or at least a great increase, for a short time, in the amount of mucus secreted by the glands of the naso-pharyngeal region. If we are careful, however, to employ only as much of the solution as will suffice to thoroughly moisten the mucous membrane to which it is applied, we shall rarely meet with any of the disagreeable symptoms mentioned. If we are careless about taking these precautions, and introduce too large a quantity of the solution, the excess will find its way into the larynx, into the nasal passages, or down upon the upper surface of the roof of the tongue, and thus give rise to a great deal of unnecessary discomfort, if not to symptoms of a decidedly alarming character, such as spasm of the glottis. A rod, probe, or wire, bent near one end at a right angle, and armed with a mop of absorbent cotton, will be found a most useful instrument for the purpose of applying the remedial solution to the naso-pharyngeal cavity. The strength of the solution must vary according to the age of the patient, the activity of the catarrhal inflammation, and other minor circumstances. In a young child I usually begin with a ten-grain solution, and soon increase to one containing twenty, thirty, or even forty grains of nitrate of silver, in a fluidounce of water. In an adult I always begin with a twenty-grain solution, and increase, if necessary, to one of double or treble that strength. In the majority of cases it is not necessary to use habitually anything stronger than a thirty-grain solution. I am not in the habit of making the applications oftener than once every other day, or three times a week; and if, by the end of the third or fourth week, I have not succeeded in allaying the major part of the naso-pharyngeal irritation, I advise the patient to take a rest of one, two, or three weeks, before I resume the applications to the affected region. If no improvement whatever results from the first series of applications, it is not at all likely that a continuance of the same treatment will prove any more successful. It is more than likely, in such a case, that adenoid vegetations are present, or that some similar condition of the vault of the pharynx exists.

In addition to these direct remedial applications, we must see to it that the patient is not indulging the habit of smoking to excess, or of imbibing frequently the stronger (undiluted) alcoholic drinks. Both of these habits tend unmistakably to promote congestion of the naso-pharyngeal mucous membrane.

The practice of injecting weak remedial solutions through the catheter into the middle ear—or at least into the Eustachian tube—is one which I have long ago abandoned, though I believe that it is still very commonly followed by European specialists. The good effects produced by the application of remedies to the naso-pharyngeal cavity are not by any means confined to that particular region; they extend promptly to the neighboring Eustachian tube, and even to the middle ear proper, and we may place sufficient confidence in this extension of a beneficial therapeutic influence, to justify us in abstaining from all direct interference with the deeper regions. I know that European authorities are all against me in this opinion, but my own experience, and that of at least some of my brother specialists, warrant me in maintaining it strongly.

While the treatment of the naso-pharyngeal disease often succeeds in restoring the middle ear to a normal condition without the aid of any other measures, it is better, as a rule, to employ systematically inflations by Politzer's method, in addition to the naso-pharyngeal treatment, just as soon as the ear has been free from pain for a period of two or three consecutive days. The beneficial effects of this procedure are to be attributed in part to pressure upon the swollen mucous membrane of the Eustachian tube and middle ear, in part to the restoration of that condition of equilibrium to which I have already made reference, in part to the actual expulsion of some of the mucus or muco-pus contained in the middle ear, and perhaps also in part to the breaking up of any fresh adhesions that may have formed between different parts of the membrana tympani, or chain of ossicles, and the neighboring walls of the cavity. Experience has shown that excellent results are obtained by resorting to Politzer's inflations only on alternate days; and it has been found, furthermore, that three or four successful inflations, at each visit or sitting, suffice. In a few cases we shall find it necessary to employ the catheter, in order to gain an entrance for the air into the middle ear; but in the great majority of instances we shall find no need of subjecting the patient to this very unpleasant operation.

In persons who are somewhat depressed in health, especially if they have passed the age of fifty, it is not an unusual experience to fail in our efforts to restore the affected ear to its normal condition, either in appearance or in function. The naso-pharyngeal mucous membrane seems to respond well enough to treatment, but the Eustachian tube and middle ear lag behind, and display very little recuperative power. Under these circumstances, I persevere in the treatment for three, four, or perhaps five weeks, using as adjuncts counter-irritation behind the ear (tincture of iodine every night, or cantharidal collodion every fifth or sixth day), and even sometimes local blood-letting (one or two leeches in front of the tragus). If the affection still remains stubborn, and if the patient can afford to take such a trip, I urge the advantages of a decided change in climate, scene, and diet, for a period of a few weeks. This pleasant prescription has, in my experience, repeatedly accomplished what my local measures have been powerless to effect. The dryness afforded by a decidedly sandy soil, and the protection from strong winds conferred by pine forests, are two important features to be sought after in the selection of such a temporary place of residence. But if these peculiarities of soil and surroundings can only be obtained at the cost of considerable personal discomfort, such as is caused by a poor diet, uncomfortable living quarters, and an uncongenial social atmosphere, I think that a mere pleasure trip, in which the exhilarating effects of travel constitute the chief curative factor, should be given the preference.

This is the proper point at which to consider the question, how far our treatment should be modified when we find the middle ear filled with a serous or mucoid exudation. This state of things, which is commonly termed *otitis media serosa*, or *otitis media mucosa*, naturally suggests the propriety of incising the membrana tympani, and evacuating the fluid contents of the middle ear through the artificial opening thus established. The operation is not usually a difficult one, and the immediate results of evacuating the fluid are often brilliant, but, unfortunately, they are very apt to be of only short duration. The fluid returns; a fresh impetus is given by the incision to the tympanic irritation; and we find, after the lapse of a few days, that the patient is in precisely the same condition as that in which he was at the time when the operation was performed. At the present time I very rarely resort to paracentesis of the membrana tympani for the relief of the condition now under consideration; and my impression is, that the best authorities, at least in the United States, hold very nearly the same views that I do with regard to the efficacy of this procedure. The presence of serum or mucus in the drum-cavity is one of the legitimate phenomena of an acute, catarrhal inflammation of the middle ear, and calls for no material modification of the treatment commonly adopted in cases of that affection.

The operation of paracentesis of the membrana tympani will be described hereafter, under the head of Acute Purulent Inflammation of the Middle Ear.

The term *chronic catarrh of the middle ear* is very commonly applied to a variety of conditions, which are probably quite distinct from each other in their mode of origin and nature, but which are characterized by the same train of symptoms, viz., progressive deafness, subjective noises in the ears, and an intact drum-membrane. For purposes of convenience, we may roughly divide these cases into three groups. In the first, we may place those cases which are characterized by evidences of congestion and infiltration of the mucous membrane of the middle ear, associated with a similar condition of the naso-pharyngeal mucous membrane. *Chronic, hypertrophic, catarrhal inflammation of the middle ear* would be a proper expression to employ in designating these cases. The characteristic features of the second group of cases are these: a very transparent membrana tympani, revealing quite clearly the lower end of the long process of the anvil, the dark niche of the fenestra rotunda, and the intervening whitish region of the promontory; an apparently unobstructed Eustachian tube; and, finally, a perfectly smooth, or slightly ridged, pale, thin pharyngeal mucous membrane, traversed perhaps by two or three dilated, superficial veins. A process of atrophy and sclerosis will explain all of these appearances, and we may therefore designate the cases belonging to this second group by the term *sclerosis of the mucous membrane of the middle ear*. Finally, we may place in the third group all those cases in which we are unable to discover any lesions of sufficient gravity to account for the marked impairment of the hearing. To explain the deafness in such cases, we are obliged to resort to mere guessing: there may be an anchylosis of the stapedio-vestibular joint, brought about by a rheumatic or other inflammation of the annular ligament, or of the tendon and sheath of the stapedius muscle; calcareous material may have been deposited in these structures, or in the secondary tympanic membrane at the round window, and thus an anchylosis may have been produced; an exostosis, or a more diffuse hyperostosis, may hamper the stirrup in its action, or may limit the excursions of the membrane at the round window; and, finally, the lesion may be located at some point in the course of the auditory nerve. All of these lesions have been found after death, but with our present knowledge we can only conjecture their existence during a patient's lifetime.

The *prognosis*, in chronic catarrh of the middle ear, is decidedly unfavorable. In the cases which belong to the first group, the patient is very apt to hear better at one time than at another, and by appropriate treatment we can sometimes improve the condition of the hearing to an appreciable degree. In cases belonging to the other two groups, however, and also in very many, perhaps the majority, of those belonging to the first, we cannot encourage the patient to hope for any improvement. On the other hand, we may make the statement that, in very many cases, the progressive quality of the disease is lacking: a certain degree of impairment of the hearing is reached, and then for years, perhaps for the remainder of one's life, no further diminution takes place.

If a more or less active naso-pharyngeal catarrh exists, with some congestion of the middle ear, the *treatment* appropriate for this condition must be adopted.[1] Some patients are much more anxious to be relieved of the distressing tinnitus that often accompanies this affection, than of the deafness. If there are sufficient grounds for the belief that a sluggish gastric digestion is promoting the naso-pharyngeal irritation, and secondarily the tinnitus, we may sometimes materially diminish the severity of this distressing symptom by prescribing dilute nitro-muriatic acid, in doses (three times a day, immediately after meals) of from three to ten drops, to be taken in a sufficient quantity of water. In a few cases, the bromides afford some relief, and the same is true of counter-irritation behind the ear. Active out-door exercise will also be found beneficial in some cases. Chronic tinnitus is, in the main, about as incurable as cirrhosis of the liver.

ACUTE PURULENT INFLAMMATION OF THE MIDDLE EAR.—This form of inflammation of the middle ear, like the catarrhal variety, usually owes its origin to an extension of the inflammation from the naso-pharyngeal space to the tympanic cavity, by way of the Eustachian tube. In scarlet fever, smallpox, syphilis, diphtheria, and perhaps typhoid fever and measles, the inflammation peculiar to these diseases may develop primarily in the middle ear, in the same manner as it does in the pharynx and naso-pharyngeal space. Exposure to cold is also a very common cause of the inflammation, and not a few cases owe their origin to bathing in salt water, some of which penetrates into the middle ear by way of the Eustachian tube. The nasal douche and the posterior nasal syringe sometimes act in the same way. The inflammation of the middle ear observed in cerebro-spinal meningitis may be due in some instances, possibly in all, to an extension of the disease from the cranial cavity to that of the middle ear. The same remark is probably true of those rare cases in which an otitis media acuta develops in consequence of an attack of sunstroke or heat-prostration. Finally, direct violence may be the exciting cause of the disease.

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[1] See page 316.

Symptoms.—In its early stages, an acute purulent inflammation of the middle ear is not distinguishable, in its subjective and objective phenomena, from the acute catarrhal variety. The pain, it is true, is apt to be more severe, and a point is soon reached at which the objective appearances show clearly that the disease is to be of the purulent variety. The drum-membrane either presents a dry, red, and tense appearance, or else all the tissues at the inner end of the external auditory canal appear to be soaked, and a small quantity of free exudation may be found on the lower wall of the canal. Beneath this white coating of soaked and loosened epithelium, which can generally be removed without difficulty, there will be found the red and swollen tissues of the inflamed drum-membrane. If the swelling is moderate in degree, the posterior half will probably be found in a bulging condition, but when the swelling is more marked we must not expect to find any recognizable bulging of the membrana tympani. If at this time a vent is not established artificially in the membrane, the continued pressure upon its inner surface will sooner or later cause one to form, and thus afford an outlet for the pent-up secretions; for the swelling of the parts around the tympanic orifice of the Eustachian tube prevents all escape of fluids by way of this channel. In such diseases as scarlet fever, diphtheria, and smallpox, it is probable that a certain local lack of vitality, or ulcerative tendency, co-operates with the pressure in producing the perforation. Every part of the drum-membrane is liable to become the site of such a spontaneously formed opening, but in a majority of instances the anterior inferior quadrant seems to be the favorite locality. As soon as a vent has been established, the pain usually begins to abate. The discharge continues for a variable length of time, generally from one to three weeks, and finally ceases. This occurrence usually takes place simultaneously with the healing of the perforation. The swelling and redness then disappear, and the hearing returns to its normal state.

While the simple course which I have just described, is that of the majority of cases of acute purulent inflammation of the middle ear, in not a few instances the disease runs a more complicated course, or even assumes a fatal form. The more important of these complications will be considered in the sections devoted to fractures of the temporal bone, chronic purulent inflammation of the middle ear, and diseases of the mastoid process. The participation of the cervical and post-auricular glands in the inflammatory process is a noticeable feature in quite a large proportion of cases of acute purulent inflammation of the middle ear. This sympathetic inflammation of the glands rarely calls for special attention.

In the simpler forms of acute purulent inflammation of the middle ear—and they constitute the great majority of cases—the prognosis is favorable, both as regards recovery of the sense of hearing, and as regards the effects of the disease upon the general health. There is a widespread belief among non-professional persons, that a perforation in the drum-membrane, no matter how established, means the destruction of the power of hearing. This is, happily, an error, and we may assure our patients with the greatest confidence that the mere establishment of a perforation in the membrana tympani, whether produced directly by disease or by the cutting edge of the knife, exerts little or no influence prejudicial to the hearing. In the vast majority of instances the perforation heals as soon as the discharge from the middle ear ceases. In fact, it often heals too soon, that is, before the swollen condition of the walls of the Eustachian tube has sufficiently subsided to permit the fluid secretions of the middle ear to find an outlet by this channel; and under these circumstances the membrana tympani is very likely to be subjected to considerable tension, from the pressure of these accumulating secretions.

The duration of a visible discharge from the ear is very variable. It often lasts only a few days, and then again it may continue for a period of several weeks. If the case pass into a chronic condition, the discharge may continue for years.

Inasmuch as the membrana tympani forms, anatomically, a part of the external auditory canal as well as of the middle ear, it may participate in the inflammation of either of these regions. Under certain circumstances, therefore, it may be difficult or even impossible to determine, by mere inspection, whether the appearances presented by the membrana tympani indicate a primary inflammation of the middle ear, or merely an extension of one that developed originally in the external meatus, and spread thence not only to the membrana tympani but also to the cutaneous wall of the osseous portion of the meatus. In the great majority of instances in which the true significance of this combined myringitis and otitis externa diffusa cannot be learned by mere inspection of the parts, we may easily arrive at a correct conclusion by testing the hearing of the affected ear, and by ascertaining how much pain the patient has experienced. If he can hear the ticking of a watch at a distance of several inches from the affected ear, and if he has had very little pain—possibly none at all—we may be confident that we are dealing with a case of primary inflammation of the external auditory canal, involving the dermoid portion of the drum-membrane. On the other hand, a primary inflammation of the middle ear, of sufficient severity to involve the coverings of the osseous position of the external auditory canal, could scarcely run its course so far without producing severe pain.

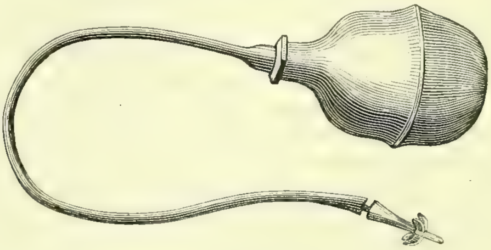
Treatment.—The most urgent indication, in the treatment of an acute inflammation of the middle ear, is to afford relief from the pain, which is sometimes severe. In young children, it is often an easy matter to accomplish this by simply applying heat and moisture in close proximity to the inflamed parts. In carrying out this procedure, however, it is important to pay considerable attention to details. The child should lie upon the side corresponding to the well ear, and water at a temperature of about 100° F. should be poured into the outer canal of the inflamed ear until it seems to be full. Then a hot, flaxseed-meal poultice, or a pad composed of several thicknesses of flannel wrung out of hot water, should immediately be placed over the ear and surrounding region. As an outside covering, and also as a means of holding the poultice properly in its place, a flannel cap with strings that can be tied under the chin, may be adjusted. As soon as the poultice or the hot cloths seem to have lost their heat, fresh ones should be ready at hand to supply their places. By this procedure, which brings the heat and moisture in close proximity to the inflamed parts, we shall rarely fail in children to arrest an acute inflammation of the middle ear, provided that it be not due to some specific poison like that of scarlet fever or diphtheria, and provided that the disease be not of too long standing. In adults, also, this plan of treatment is sometimes successful, but it is rare that a full-grown person will consent to submit to treatment of any kind, until the time has gone by when such simple, home-made measures are competent to arrest the progress of the inflammation. Still it is often possible, even at this late stage, to quiet the pain and arrest the further progress of the inflammation by the measures which I have described, and it is therefore well to give them a trial. Now and then we shall encounter a patient to whom some form of dry heat affords greater relief than does the poultice or the hot douche. A soft, flannel bag filled with dried hops, and heated thoroughly before an open fire or in the oven, will be found to serve an excellent purpose in such cases. Bran, oatmeal, or coarse salt may be used in the place of the hops. A rubber-bag filled with hot water, and covered with flannel, is also a good substitute for the hop pillow. A still more perfect method of applying heat and moisture to the inflamed drum-membrane, is by means of a gravity douche, provided with a pronged, hard-rubber nozzle, such as will be described hereafter. By refilling the tin reservoir ("Clark's douche") or the rubber bag as often as may be required, a stream of warm water may be kept playing upon the inflamed parts as long a time as may be wished.

If these simpler measures fail, we may, according to the age, sex, and strength of the patient, apply from one to four leeches either immediately behind, or immediately in front of, the auricle, as close as possible to the tragus. As a rule, however, it will be found that the cases in which warm applications and rest in bed fail to alleviate the pain, are characterized either by a bulging condition of the posterior half of the drum-membrane, or by an intense inflammation of all the soft parts bordering upon the upper part of the membrane, without any recognizable bulging. The pain is due to the pressure of accumulated secretions upon an inflamed, and therefore highly sensitive, mucous membrane, and the most rational and conservative procedure is to remove the pressure by establishing an artificial opening in the membrana tympani, through which the secretions may find an easy escape. I will quote here briefly from my work on ear diseases, already referred to, all that I think it necessary to say with regard to this operation: If performed with a reasonable degree of care by a physician who knows something about the anatomy of the middle ear, it may be considered as a perfectly safe operation. There is but one real danger, and that is this: the operator may, with the point of his knife, injure the delicate attachments of the anvil, or drive the stirrup into the vestibule with such force as to rupture the annular ligament, or injure some of the delicate labyrinthine structures. However, the attachments of the stirrup to the oval window are quite strong, and this ossicle can unquestionably be handled rather roughly without serious injury being caused to the organ of hearing. The attachments of the hammer are also very powerful. On the other hand, those of the anvil are very feeble. This ossicle is, as it were, suspended between the hammer and the posterior wall of the tympanum. The bands which attach it to the hammer are extremely delicate. From these the anvil derives little or no stability; but from the peculiar interlocking of the articular surfaces it derives probably its chief strength. At best, however, this ossicle possesses very feeble supports, and may easily be disconnected from the hammer by the manipulations of an ignorant or careless operator. In incising the membrana tympani, therefore, we should so guide the end of the slender, spear-pointed knife that it shall not strike the end of the long process of the anvil, or the attached head of the stirrup. All these parts which are to be avoided, occupy, fortunately, a comparatively small portion of the area within which the knife can be used. This dangerous region occupies about half (the upper half) of the posterior superior quadrant. Hence we may, without the slightest fear of injuring the ossicles, begin our incision a little above the dividing-line, between the upper and lower posterior quadrants, and midway between the handle of the hammer and the periphery of the membrane, and carry it down nearly to the lower limit of the latter. The membrana tympani secundaria need give no anxiety, as it lies safely concealed in its niche of bone, quite out of reach of any straight instrument that may be introduced through the outer meatus. Furthermore, if the point of the blade be carried too far inward, the only result will be an incised or punctured wound of the mucous membrane covering the inner bony wall of the tympanum, a result that has no significance in the pathological conditions now under consideration.

It is by no means an indifferent matter what sort of a cutting instrument is used in making an opening in the membrana tympani. In a general way, it may be said that a spear-pointed, two-edged blade is the best adapted to this purpose. In the construction of such a knife—or *myringotome*, as it is often called—regard must be had to the relations of the drum-membrane to the inner wall of the tympanum. Thus, for example, it is safe to assume that we shall never be called upon to incise a membrane whose posterior half occupies a position less than two millimetres distant from the inner wall of the tympanum. We may also take it for granted that we shall never find it necessary to incise a membrane so distended that it occupies a position more than five millimetres distant from the inner wall of the tympanum. It is therefore unnecessary to have the cutting edges of the spear-pointed knife of greater length than five millimetres. The myringotomes which I use have cutting edges only three and a half millimetres in length, and I find them amply long. In the next place, it is desirable that the spear-headed blade should be quite broad at its base; the breadth in this case being measured from cutting edge to cutting edge. In children and sensitive people, a single stab is often all that we can obtain, unless we resort to the use of an anæsthetic. Under such circumstances the broader the blade of our knife, the greater will be the length of our incision in the drum-membrane. In my instruments the greatest breadth is barely three millimetres. Possibly a breadth of three and a half millimetres would be found better adapted to all the purposes for which a myringotome is used; but we must not forget that we are often called upon to operate in a canal of very small calibre, and that even a slight increase in the size of the knife may be sufficient to greatly increase the difficulty of the task of operating successfully. It is largely a matter of individual preference whether a straight or a slightly bent myringotome shall be employed. After using both kinds, I have gradually fallen into the habit of using only the straight instrument. It seems to me that I can control such a straight myringotome more perfectly than I can a bent one. Those which I use are made from a single piece of steel, sixteen centimetres long; the slender shank, together with the blade, measures seven centimetres, while the eight-sided, roughened handle measures nine centimetres.

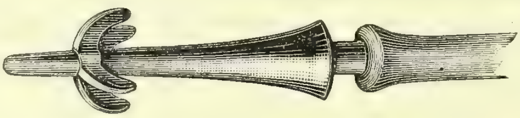
After an opening has been made in the drum-membrane, the hot applications described above should be continued until the pain has been relieved and until a free discharge has been established. Then heat is no longer required. The chief care from this time forward must be to secure the most perfect cleansing possible of the external auditory canal and outer surface of the drum-membrane, as long, at least, as the discharge continues. At first thought, one would be disposed to consider this part of his therapeutic task as very easy to accomplish. The fact is, this most important part of the treatment of purulent affections of the middle ear is rarely carried out properly. Two or three serious difficulties usually stand in the way. Of the numerous ear-syringes sold in the shops, both here and abroad, many are utterly worthless for the purpose; and of the remainder, scarcely one is fit for anybody but an expert to use. The syringing of the ear, however, must as a rule be carried out by a nurse or by some member of the family, or possibly even by the patient. The fear of injuring the ear by introducing the nozzle of the syringe too far into the auditory canal, is almost universal, and as a result the pus and masses of cast-off epidermis lying next to the membrana tympani remain undisturbed by the current of water ejected from the syringe. They soon become putrid, and so increase the existing inflammation. If instructions are given to pull the auricle upward and backward during the operation of syringing, a more perfect cleansing of the parts is often obtained. But if the canal is swollen and tender, as is very apt to be the case, even this procedure will aid very little in rendering the syringing successful in its results. Several years ago I devised an instrument which has been sold under the name of "Reynders's douche," and which has been tried now for so long a time and so extensively that I feel no hesitation in recommending it as a very useful ear-syringe or douche. It consists of a soft-rubber bulb or reservoir, from one pole of which a short, flexible, rubber tube, eight or ten inches in length, leads to a hard-rubber tip or nozzle, armed with lateral prongs that prevent the instrument from being pushed too far into the auditory canal.[1] This pronged nozzle, which constitutes the important part of the apparatus, is represented correctly in the accompanying illustration (Fig. 894). Instead of simple water I am in the habit of using, by preference, a saturated solution of boracic acid—two teaspoonfuls of the coarse crystals, or of the powdered acid, to the pint, or one tablespoonful to a litre of water. As boracic acid does not dissolve readily in tepid water, it is better to employ water that is decidedly hot, and then allow it to cool down to the proper temperature (about 100°–105° Fahr.) before it is injected into the ear. For cleansing purposes, it will be sufficient to douche the ear three or four times a day at first, and then, as the discharge becomes less active, we may resort to this procedure less and less frequently. When the discharge has apparently ceased, and when the water that escapes from the ear during the douching procedure seems to be quite clear, we may venture to dispense with the instrument altogether.

Fig. 893.



Ear-douche.

Fig. 894.



Hard-rubber, pronged ear-nozzle; full size.

This is perhaps the proper place at which to call attention to a remedial procedure which is very commonly employed, but which is, as I believe, objectionable. I refer to the instillation of warm laudanum and sweet oil into the external auditory canal, a remedy which is widely recommended by physicians in all cases of pain in the ear. This procedure does indeed, in some instances, diminish the pain, but it accomplishes this in an illegitimate manner, if I may so express myself. It deadens the nervous sensibility of the inflamed parts, but it does not arrest or diminish the inflammation. On the contrary, both the oil and the alcohol in the laudanum tend rather to increase the inflammation: the former, by reason of the numerous germs of vegetable mould which it contains, and which may quickly take root in the inflamed tissues; the latter, by reason of its well-known irritating properties.

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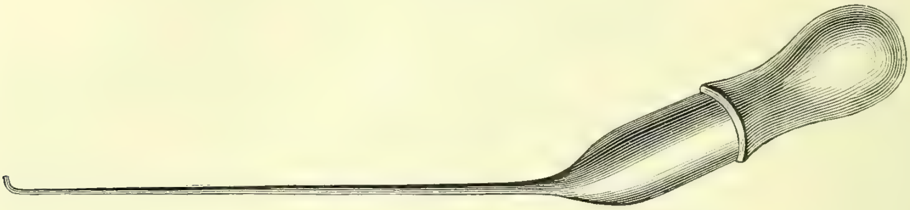
[1] At the present time, the best modification of this douche, for sale in New York, is that manufactured by T. Angelo, of Thirty-first Street and Fourth Avenue. The bulb contains a decidedly larger amount of water than did that first manufactured, and soft, black rubber is now used in place of the coarse, white variety, for the tube which connects the nozzle with the reservoir. These modifications have materially increased the efficacy of the instrument.

In the majority of cases of acute inflammation of the middle ear, no other measures beside those which I have described will be found necessary for the restoration of the affected region to a condition of health. In a few cases, however, we find it desirable to resort to other expedients and remedies. Thus, for example, the discharge may show little or no tendency to diminish, although a period of two or three weeks may have elapsed since it first made its appearance, and although the most careful douching may have been practised. Perhaps the most common cause of this persistent discharge is what I might term a relaxed condition of the mucous membrane of the middle ear; its bloodvessels being dilated and paralyzed, and the surrounding tissues being infiltrated with serum and lymphoid cells. Such a mucous membrane needs the stimulating effects of nitrate of silver, and the problem which we have to solve is, how to bring it in contact with the diseased parts effectively and safely. If there is a large opening in the drum-membrane, the task is a very easy one. By aid of the douche and of inflations with a Politzer bag, we can usually remove the greater part of the secretions accumulated in the drum-cavity. A few drops of the solution are next to be instilled into the auditory canal, the head of the patient being turned to one side in such a manner as to favor the descent of the fluid to the inner end of the meatus; and then, after the solution has become warmed by the heat of the surrounding parts—that is, after the lapse of two or three minutes—sufficient pressure should be made upon the orifice of the canal to force the fluid contained in it to find its way into the affected drum-cavity, and perhaps also into the Eustachian tube and other outlying parts. While the pressure is being applied, the patient should be requested to perform the act of swallowing three or four times in succession, as the entrance of the remedial solution into the middle ear will thereby be materially facilitated. In cases of comparatively recent origin, weak solutions of nitrate of silver will usually be found sufficiently effective. If the perforation is as large as one-half of a millimetre in diameter, we may use, with perfect safety, solutions of from five to thirty grains to the ounce of water. I have rarely found it desirable to use a stronger solution than one containing five grains to the ounce. If the perforation is quite small, perhaps no larger than a small pin-hole, it is better to use a still weaker solution—one, for instance, that contains only two or three grains to the ounce. On the other hand, in cases in which the perforation measures as much as three millimetres in diameter, and the mucous membrane of the inner wall of the tympanum appears to be much swollen and congested, I frequently introduce a slender probe, upon whose knobbed end a bead of pure nitrate of silver has been fused, and pass it lightly over all the mucous membrane that is within reach. A single such application will sometimes arrest the discharge as if by magic, and the swelling and congestion then disappear gradually without any further therapeutic interference. If the perforation is very small, it is not an easy matter to bring our remedies in contact with the tympanic mucous membrane, at least by any of the methods which I have thus far described.

Injections by means of the Eustachian catheter, are, under these circumstances, preferred by many authorities. This plan of treatment, however, is open to the objection that it gives the patient unnecessary discomfort, and often fails to introduce the remedial solution into the middle ear. A far more direct and perfect method is by means of slender glass or metal tubes, which can easily be passed through the smallest perforation. As it is necessary to introduce only a few drops of the remedial solution, it will be found convenient to attach to the tube an elastic cap, by means of which we may both draw up into it the remedy, and at the proper moment discharge it through the perforation into the drum-cavity. The accompanying cut is a faithful representation of such a glass tube with its elastic rubber attachment. Such a "middle-ear pipette" is very likely to inject only air into the middle ear unless we take care to elevate the reservoir end a little above the level of the perforation. I need scarcely remind the reader that this apparently simple operation is not to be undertaken by everybody. Like very nearly all the manipulations necessary in either the examination or the treatment of the ear, this procedure requires skill in keeping the drum-membrane steadily illuminated, delicacy in the manipulation of the instrument, and a perfect knowledge of the whereabouts of the tip of the pipette in the middle ear.

Fig. 895.



Middle-ear pipette ; full size.

Two or three questions still remain to be answered. In the first place, we must consider how frequently these remedial applications to the mucous membrane of the middle ear should be made. It is possible that the patient will make more rapid progress toward recovery if we apply our remedies to the affected part every day, than if we make the applications only three times a week. I have not tested this point thoroughly, and cannot therefore answer the question in a positive manner. I get excellent results from applications made only on alternate days, and I have sometimes found that I could, with apparent advantage, make the intervals even longer. I have therefore adopted the rule not to see patients who are affected with a purulent inflammation of the middle ear, oftener than three times a week. As a matter of course, we must see them oftener during the acute stage of the attack ; but the rule which I have given applies only to the later stages. If the weaker solutions do not seem to diminish the discharge, I employ the stronger ones, and when these seem to increase the inflammation and the amount of the discharge, I return to the weaker solutions, or I abstain from all active interference for a few days, or I employ some other remedy. In this disease, however, I rarely find it necessary to resort to any other remedy, and the only articles that I use under such circumstances, are finely powdered iodoform, burnt alum, and boracic acid. As the condition of the ear improves under the use of nitrate of silver, there comes a time when nothing remains but a thin, scanty discharge, and there is no longer any visible evidence of active inflammation. This is the time when a minute quantity of finely pulverized burnt alum, or of alum and iodoform mixed in equal parts, or of iodoform alone, if judiciously pushed through the perforation into the tympanum, will tighten up the relaxed tissues, and virtually put an end to the disease. As far as my experience goes, boracic acid is far inferior to iodoform in its curative powers, and furthermore it occasionally seems to act as an irritant. Burnt alum is an exceedingly valuable remedy, but it is only after long experience that one can use it satisfactorily. It sometimes sets up a pathological disturbance which it is hard to control. While I should probably fail if I were to attempt to lay down any accurate indication for its employment, I may say, in a general way, that it should always be introduced in very small quantities, and never when any trace remains of active inflammation. In particularly stubborn cases, we may find it necessary to administer cod-liver oil internally, or to send the patient away from home for a period of two or three weeks. Such a change of air and scene will often effect what the most painstaking and skilful treatment has failed to accomplish.

CHRONIC PURULENT INFLAMMATION OF THE MIDDLE EAR.—A chronic purulent inflammation of the middle ear may almost invariably be traced back to an acute attack that had its origin in a "cold," or in scarlet fever, measles, or some other infective disease. In a few cases the affection begins in an insidious manner, without pain, and apparently without any exciting cause. These comparatively rare instances are observed in scrofulous or consumptive individuals, and the middle-ear disease may then be set down as being of a distinctively tubercular or scrofulous nature. The salient feature of all these cases of chronic purulent inflammation of the middle ear, is the constant or frequently recurring discharge of pus from the affected region. With regard to all the other symptoms—the degree of the diminution in the hearing power, the presence or absence of pain, tinnitus, etc., and the lesions observable by the aid of the speculum and reflected light—the cases differ to such an extent that a general description would fit only a comparatively small number. Furthermore, if we look at this question from a practical point of view, from the standpoint of one who desires to effect a cure, we shall appreciate the folly of attempting to draw anything like a general picture of the disease. Each case must be a study by itself, and when the student wishes to make a diagnosis, he must strive to render an account to himself of the changes that are going on in all the different parts of the ear. If he rests satisfied with the mere diagnosis of "chronic purulent inflammation of the middle ear," and then consults some text-book for the purpose of ascertaining what is the proper treatment for the disease which bears this name, he will often fail to arrest a discharge which might otherwise be easily checked.

As the space alloted to this article is limited, I will make no attempt to classify the different types of chronic purulent inflammation of the middle ear, but will simply describe the plan which I usually follow when I am called upon to ascertain the seat and the extent of the disease in a case of protracted discharge from this organ. Every observer has his own particular method of getting at the truth, and yet these different methods all lead to the same result. The one which I have adopted, is probably, in all material respects, the same as that employed by many other observers. It is, briefly stated, as follows: I obtain from the patient, or from the parents or guardians, as clear an account as possible of the origin and progress of the affection. It is important to learn the degree of activity of the discharge, whether constant or intermittent, whether fetid in character, and whether pale or tinged with blood. I ascertain also whether pain has been an accompaniment of the disease, and endeavor to find out the precise locality to which the pain has been referred. The value of the previous history of the case will be appreciated when we come to weigh the significance of certain lesions that may be discovered in the course of an actual inspection of the parts. We must also not forget to test the hearing of the affected ear. Then, if the case under consideration be one of a somewhat acute nature, our next step should be to ascertain the body temperature. Otherwise, we may proceed at once to an examination of the ear and neighboring parts. Pressure should be made with the finger upon the soft parts immediately surrounding the ear, and particularly upon those covering the mastoid portion of the temporal bone. An unnatural redness of the skin in this region is a valuable indication, and its presence should be noted. With all these facts in our possession—the previous history, the degree of diminution in the hearing, the body-temperature, and the condition of the skin in the immediate neighborhood of the ear—we shall be able to interpret correctly the pathological changes which we may see in the deeper parts of the organ. If the meatus is filled with pus, we must take steps to remove it, not simply in a general way, but in the most thorough manner, so as to expose to view every nook and cranny.

The question of syringing presents itself at this point. Is it best to remove the pus and other *débris* by syringing, or not? The answer to this question may be either yes or no. I never use the syringe under these circumstances: I much prefer to soak up the pus little by little, with a mop of absorbent cotton wound around the end of a slender, malleable, steel cotton-holder, and, in performing this operation, I keep the canal well illuminated and watch each step as I carry my mop deeper and deeper into the canal. If I were to syringe the meatus, I should still be obliged, afterward, to resort to the use of the mop; for the water that clings to the deeper parts of the ear and to all the irregular places, will be found to mask the true condition of the parts almost as effectively as if pus and not water covered them. It is therefore easier and better to omit the syringing, and to trust entirely to the mop. On the other hand, an unskilled person will have to employ the syringe, and he will have to interpret, as best he may, the ill-defined picture which he finds spread out before him. As an imperfect or an erroneous diagnosis leads, in very many of these cases, to equally imperfect treatment, it will be seen that I have a right to warn the reader against trusting to such an imperfect procedure as that of cleansing the ear by means of a syringe. Oftentimes we shall find it also necessary to use the slender middle-ear probe, the curette, and the angular forceps, in our efforts to clear away the obstacles that obstruct the view. These usually consist of scab-like formations, conglomerations of cheesy pus, and masses of epithelium. The latter often cling quite firmly to the underlying inflamed tissues, and require to be dissected off by means of the curette. When the mass has been detached, we can readily extract it by means of the slender, angular forceps. Irregularities of the surface must be touched and handled, if I may use the expression, with the probe or curette. In this way we often discover ulcerated areas or spots of granulation-tissue, which, under simple inspection, had seemed to be simple unevennesses of the surface. Sometimes the orifice of a sinus gets filled with cheesy pus or epithelial *débris*, and then presents the appearance of a mere white spot. Careful pressure with the end of the probe will at once reveal to us the existence of such a sinus, and by further manipulations with the same instrument we may ascertain its depth, the direction which it takes, and the presence, at some point in its course, of an exposed, bony surface, or of a loose fragment of bone. If the sinus is of sufficient size, we may gain a more accurate knowledge of its relations to neighboring cavities by the employment of a slender canula, of either metal or glass, through which, by the aid of an attached soft-rubber bulb-syringe, we may inject a stream of tepid water into the mouth of the sinus. Every mass of granulation-tissue that springs from any part of the external auditory canal should lead us to search, in the immediate vicinity, for the presence of a sinus or of a spot of carious bone. Sometimes the sinus begins at the very edge of such a granulation growth. Perhaps equally often the opening will be found in the very centre of the mass.

Our attention should next be directed to the drum-membrane. Every part of it should be laid bare, so that we may feel sure that we know, from actual inspection, what is its condition. A perforation is rarely lacking. If it be quite small, and especially if the membrana tympani at this point be decidedly thicker than normal, we may fail to discover the existence of the perforation by simple inspection. We must then take advantage of Valsalva's experiment, and watch the effects of it upon the membrana tympani. As the compressed air finds a way of escape through the perforation in the drum-membrane, it is very likely to force out into the meatus a certain amount of the fluid contents of the typanum. The locality occupied by the perforation is thus quickly revealed. In cases of this kind, we can only infer what the condition of the middle ear is from the appearance of the neighboring parts, and from a consideration of the data previously obtained. In cases in which the perforation is larger, we may obtain a direct view of the deeper parts, and if the perforation is quite large, we may be able to form a fairly accurate judgment with regard to the condition of the middle ear. Direct inspection, however, must always be supplemented by exploration with the probe. In this way we can learn the thickness and consistency of the tympanic mucous membrane, and the presence or absence of masses of epithelium and cheesy pus (the so-called cholesteatomata), especially when they lie concealed from view in the upper and posterior portions of the drum-cavity or in the antrum. In this way, also, polypoid growths are discovered at points which, to the unaided eye, seem to be covered only with a smooth though perhaps swollen mucous membrane. Bone ulcers, which are by no means rare lesions in the middle ear, can only be discovered by means of the probe.

The examination is now complete. In the great majority of cases, we know exactly what is the condition of the external auditory canal and membrana tympani, and we possess sufficient additional data to enable us to form a fairly accurate opinion with regard to the condition of the middle ear. In a few cases, the auditory canal is found to be in such a swollen condition that we are unable to gain a view of either the drum-membrane or the inner half of the meatus. Under these circumstances, we must carefully weigh the other objective phenomena, and the degree of impairment of the hearing in connection with the history of the case. The beginner may find it a very difficult task to clear up the pathology of these apparently obscure cases, but to the expert it will be comparatively easy to arrive at the truth. In our first attempt, we are obliged to go patiently through the process of analyzing each symptom, or lesion, in its relations to the others and to the history of the case. With each new case, however, this analytical process of reasoning will be found to consume less and less time, until, finally, we cease to be conscious of any such complicated process of reasoning, and arrive, as it were intuitively, at a correct judgment with regard to the nature of the malady. As I cannot hope, in a short article such as this, to clear up all the difficulties that surround the task of making a correct diagnosis, I will take up, in turn, the more important symptoms and lesions, and will endeavor to show the significance of each.

When *pain* occurs in the course of a chronic discharge from the ear, we may look for its source in a variety of places. It may be due, for example, to the development of a furuncle in the walls of the external auditory canal.

An irritating discharge from the ear is very apt to induce furuncular inflammation. The condition may easily be recognized upon an examination with the speculum and reflected light. The escape of pus from the middle ear under pressure, such as exists when a small perforation in the membrana tympani becomes blocked in any way, is a very common source of pain. After we have once verified the existence of such an insufficient or obstructed outlet, we can, by the aid of other symptoms and lesions, measure the extent of the harm that is being caused by the obstruction. Finally, decided pain of an obstinate character may be a very prominent symptom in chronic purulent inflammation of the middle ear, without the slightest trace of a condition of obstruction, or of active inflammation, of the visible portions of the middle ear. The pain, under these circumstances, is probably due to a chronic hypertrophic osteitis of the mastoid process. Farther on, I shall consider both of these classes of cases more fully.

Tenderness on pressure may exist in the auditory canal, or at any point in the immediate vicinity of the ear. Tenderness in the meatus signifies either a localized, furuncular inflammation, or a diffuse periostitis of the canal. In the case of this latter condition, we must endeavor to distinguish between a mere superficial inflammation, due to the exposure of the parts to a constant flow over them of an irritating pus, and one that represents a direct extension of a more or less serious inflammation of the middle ear. Tenderness behind and above the ear, if developed in the course of a chronic purulent discharge from the meatus, always means one of two pathological processes: either an inflammation of the soft parts of the auditory canal has travelled outward along the canal to the parts behind and above the ear, or an inflammation involving the antrum and cellular structures of the mastoid process has spread along the mastoid emissary veins to the outer periosteum. A study of the condition of the auditory canal will usually enable us to determine correctly which of these two processes is the one at work in the case under consideration.

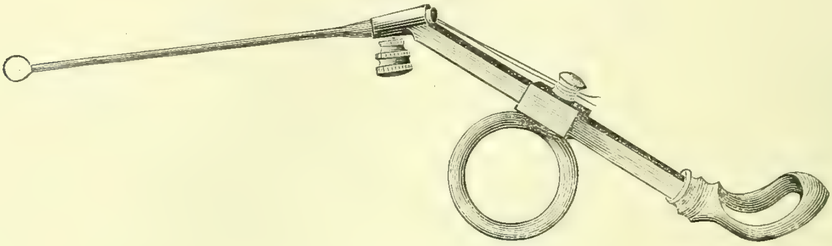
In a large proportion of cases of chronic discharge from the ear, we may safely take it for granted that the discharge is kept up by a limited patch of *bone-caries*, usually superficial in character, or by a mass or masses of *granulation-tissue.* The latter condition is by far the more common of the two, though the former is by no means rare. There is undoubtedly such a thing as a persistent and fairly active discharge without either of the above-named conditions, but I am convinced that such a state of things is comparatively uncommon. Hence the necessity, if we desire to arrest the discharge, of making a most thorough and minute search for some hidden granulation-growth. In more than one case of obstinate discharge I have tried in vain to effect a cure. The perforation in the membrana tympani being small (a millimetre or a millimetre and a half in diameter), I have not been able to learn much, from actual exploration, about the condition of the middle ear. In a few of these cases I have had the good fortune, after the lapse of weeks or months, to discover the existence of a small polypoid growth in the tympanic cavity. At first it was too small to come within my limited range of vision, but as the mass increased in size it finally encroached upon the small field bordered by the edges of the perforation. The case then became quite clear, and the removal of the growth with the wire snare promptly put an end to the discharge. In some cases I have succeeded, by aid of the slender middle-ear probe, bent at a right angle near the tip, in bringing into a view a small polypoid growth, which the moment before had been completely concealed from view. With regard to bone-caries, I have very little to say that will be of practical value. My impression is, that I have found these patches or areas of bone-caries more often at the posterior end of the tympanum, just at the edge of the entrance to the antrum, than at any other part of that cavity. The floor of the tympanum, and the lower part of the inner wall, just above the floor, are also localities in which such an area of bone-caries is apt to be found. Fistulous tracks in the region immediately above the membrana tympani are not uncommon.

The *prognosis*, in all cases of chronic purulent inflammation of the middle ear, must be guarded. Our knowledge of the exact nature, location, and extent of the disease, is never sufficiently exact to justify us in giving a positively favorable prognosis. We are justified, however, in making the statement that judicious treatment succeeds, in the majority of cases, in either arresting the discharge entirely, or in rendering it so scanty that no outward evidence of its existence can be discovered by the ordinary observer. As far as danger to life is concerned, we may give a decidedly favorable prognosis in all cases in which the perforation in the membrana tympani is of good size, and the external auditory canal not materially narrowed by exostoses. The cases that are likely to assume a grave aspect, are those in which pus stagnates in the deeper recesses of the middle ear. In a few instances, the removal of mechanical obstacles (pus, masses of epidermis, granulation-growths, and undue swelling of the mucous membrane in the neighborhood of the labyrinthine windows and around the joints of the ossicula) decidedly improves the hearing, but in a large proportion of cases treatment fails to materially benefit the patient's condition in this respect. In fact, the hearing is sometimes rendered less acute; for, upon the arrest of the discharge, the chronically inflamed tissues become contracted, dry, and rigid, and the mobility of the ossicular apparatus is thereby impaired.

In principle, the *treatment* of these cases of chronic purulent inflammation of the middle ear is very simple. As stagnation and decomposition of the secretions are the chief source of all the inflammation, ulceration, and growth of granulation-tissue in the middle ear and external auditory canal, so our therapeutic efforts must be directed chiefly to the frequent and thorough removal of these secretions. In very many cases, this part of the treatment can be carried out perfectly well by the patient at home. According to the activity and the degree of foulness of the discharge, the ear should be douched or syringed from one to four or five times daily, either with simple, tepid water or, preferably, with a warm, saturated solution of boracic acid (about two drachms to the pint). If a sinus in the bone exists, or if there is a tendency to the accumulation of secretions in the mastoid antrum, or in the upper half of the tympanic cavity, the surgeon will have to wash out these regions, at least two or three times a week, by the aid of a suitable canula attached to a gravity-douche, or to a bulb-syringe. If the skin of the auditory canal, or the mucous membrane of the middle ear, be ulcerated, or in a granulating condition, at any point, we must apply pure nitrate of silver to the affected spot. A bead of the caustic can readily be fused upon the end of a probe or cotton-holder, and by means of such an instrument we may readily cauterize only the limited area that requires such treatment. A separate mass of granulation-tissue, no matter how small, can best be gotten rid of by means of a wire snare or loop, such as can be prepared in a few moments in the admirable instrument known as "Blake's snare." This instrument, which was first described as "Blake's modification of Wilde's snare," is so different from, and so decidedly superior to, the latter instrument, that I have no hesitation in speaking of it as simply Blake's snare. (Fig. 896.)

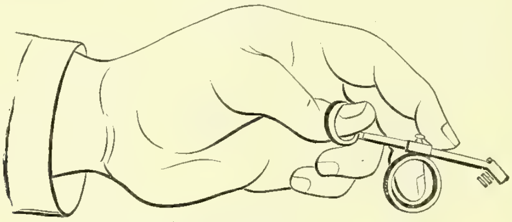
In the case of the smaller polypoid growths of granulation-tissue, the operation of passing the loop of wire over the growth is so comparatively simple that no particular description of it need be given. In the case of the larger growths, of which only the outer portion can be seen, there may be some doubt as to what is the best course to pursue in removing them. If the polypus is so large as to fill the outer orifice, it may be removed by means of an ordinary dressing-forceps, or, better still, by means of a Hinton's polypus-forceps, provided that the growth be not of the firm, fibrous variety. The mass should be firmly grasped between the blades of the instrument, and should then be separated from its deeper attachments by a combined rotary and pulling motion, or simply by direct traction. If the growth is situated more deeply in the canal, and reflected light is required to render the mass visible, such an instrument as Hinton's forceps will be found awkward to manage, and likely to produce pain. Blake's snare, armed with malleable steel wire (size No. 37), is the proper instrument to use under these circumstances. By aid of the slender, silver probe, the surgeon can ascertain whether the mass grows from the cutaneous walls of the canal, or from the middle ear or mastoid cells. Where the growth is of such size as to fill the canal, it is not necessary that he should satisfy himself of the exact situation of the base of the polypus before applying the loop of wire. It is sufficient for him to ascertain by actual probing that he can pass his snare over the mass to a given depth (distance from the orifice of the meatus) without encountering any obstacle. The loop is then pushed in over the mass to this depth, and tightened sufficiently to hold the polypus firmly in its grasp. If the growth be succulent and not very firm, and especially if it can easily be rotated about its long axis, steady traction should be made, in the hope of pulling out the polypus, peduncle and all. In not a few cases this object will be attained; but even if the effort fail to remove the entire growth, at least as much of the mass will be torn off as would have been if the wire had been made to cut through the polypus instead of simply grasping it firmly. If the growth is firm in texture, and not easily rotated, it is better to use the loop simply as a means of cutting off portions of the growth. Under these circumstances traction should not be employed. As soon as the bleeding has ceased, and the portion cut off by the wire loop has been removed with the bent forceps,

Fig. 896.



Blake's snare; somewhat reduced in size.

Fig. 897.



Proper method of holding Blake's snare.

the remainder of the growth is to be treated in precisely the same way as the first portion. The wire loop is to be applied again and again until the base of the growth has been cut away to the level of the surrounding mucous membrane or skin. If the polypoid mass springs from some portion of the external auditory canal, it will be found as a rule decidedly firmer in texture and more sensitive than one of middle-ear origin. It will also not possess the same degree of mobility as the latter. The polypi of middle-ear origin, we shall find, spring more frequently from the upper and posterior portion of the tympanum (entrance to the antrum) than from any other locality.

It is a good rule in practice not to resort to the use of caustics until the base or peduncle of the polypus has been cut away with the snare to the level of the surrounding parts (skin or mucous membrane). Furthermore, in deciding whether the peduncle has been cut away to the proper level, we are not to trust to the sense of sight alone ; the behavior of the peduncle, when circumscribed by the end of the probe, furnishes the only trustworthy guide to a knowledge of the exact relations which this peduncle bears to the surrounding parts. When the mass has been so far extirpated that we cannot encircle it with a wire, we may, with benefit to the patient, resort to the use of caustics and astringents.

In a few cases, after the removal of a polypoid growth from the ear, the hemorrhage from the divided vessels is quite active. This occurrence, however, need give us no anxiety, as the bleeding very rarely proves to be excessive. In placing the loop of wire over granulation-growths in the immediate neighborhood of the middle ear, great care must be taken not include one of the ossicles, especially the handle of the hammer, in the loop. After we have cut away as much of the growth as we can with the wire loop, if the remaining stump or base rise in the slightest degree above the surrounding level, we should apply caustic to the exposed raw surface. Care, however, must be taken not to cauterize the part too deeply. By some excellent authorities chromic acid is preferred to nitrate of silver as a caustic. While I feel more at home in the use of nitrate of silver, I am disposed to look upon chromic acid as a most useful caustic. The only objection that I can raise against it, is this : it must be applied to the affected part with decided caution, or its destructive action will extend to a greater depth than is desirable. The remedy should only be used in a fluid state (after deliquescence has taken place), as the old practice of depositing a minute crystal of the acid upon the part to be cauterized, often leads to the development of a severe and troublesome inflammation. Furthermore, it is a good plan not to make caustic applications oftener than on every other day. When we believe that we have accomplished all that is necessary in the matter of levelling the granulating area, we should abandon the caustic treatment, and apply powdered burnt alum to the affected spot. We should transport the alum, grain by grain, on the moistened end of a slender probe, until the part is well covered with the powder. The old plan of blowing the powder indiscriminately over all the deeper parts of the ear, is open to decided objections. Powdered iodoform, or boracic acid, may safely be blown, in a thin layer, over all these parts, but it is not good practice to use alum in this unrestricted manner, as it sometimes greatly aggravates the inflammation which we are striving so hard to control. When we find that the ulcerative process has involved the underlying bone, we must not be surprised if our therapeutic efforts prove only partially successful. Various plans of treatment have been tried for the cure of bone-caries in the outer or the middle ear, but I have not found any of them of special value. In cases of this nature, I carry out precisely the same plan of treatment as that which I have just described. As soon as I have succeeded in clearing the cavities of granulation-growths, I dismiss the patient with careful instructions about cleansing the ear once or twice every day. Under this plan of systematic cleansing, the bone-disease is sometimes arrested, and the discharge ceases. Relapses, however, are common.

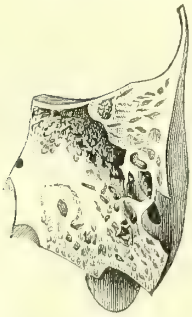
In a few cases, as I have already said, there is no discoverable disease of the bone, the external auditory canal appears to be sound, and nothing like granulation-tissue can be found in the middle ear. The promptly successful results of the treatment in these cases warrant the conclusion that the only pathological lesion upon which the discharge depends, must be a relaxed condition of the mucous membrane of the middle ear; a condition which, as I have already said, is probably characterized by paresis of the walls of the bloodvessels, and by the consequent infiltration of the mucous membrane with lymphoid cells and the watery elements of the blood. The application of a solution of nitrate of silver (from two to five grains to the ounce of water) to the entire lining membrane of the middle ear, either by means of the middle-ear pipette or in some coarser manner, usually brings the relaxed mucous membrane soon back to a quiet, non-secreting condition. In these cases, as a matter of course, the diagnosis can only be made after a cure has been effected.

With regard to the employment of more general measures in the treatment of chronic purulent inflammation of the middle ear, I must refer the reader to the remarks on acute purulent inflammation of this region.

Diseases of the Mastoid Process.

It has been the custom to speak of diseases of the mastoid process as if they were separate and distinct from the different types of inflammation of the middle ear. While, as a matter of fact, the two groups of diseases are inseparably connected, as a matter of expediency it is better that this custom of separating them should be maintained. The mastoid cells ordinarily participate in whatever inflammatory processes take place in the tympanic cavity, without manifesting any symptom that is likely to attract our attention to that quarter. In some cases, however, the symptoms pointing particularly to this region outweigh the others, and under such circumstances no hesitation need be felt in grouping these cases together under the title of diseases of the mastoid process. Before attempting to portray this class of cases, I will first describe briefly some of the more important anatomical features of the mastoid region, as it will be very difficult, without such knowledge, to understand the varying picture of mastoid disease.

Fig. 898.

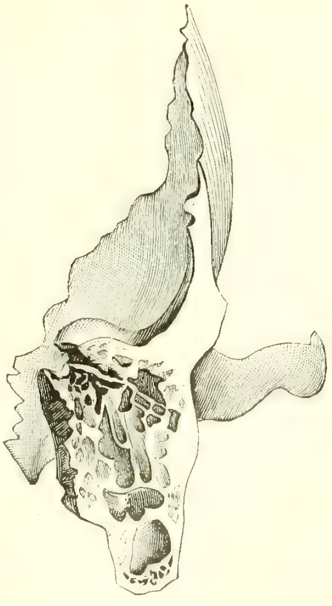


Mastoid process of a child two or three years old. The darkly shaded region, above and toward the left, represents the antrum. A large pneumatic cell, whose thin outer wall of bone has been broken away, may be seen a little above the tip of the process.

At birth, the mastoid process consists of a small, flattened tuberosity, containing but one cell of material size—viz., the antrum. During the first year of infancy this cavity usually lies so near the outer surface of the process that only a thin wall of bone, perhaps only a millimetre in thickness, separates it from the external periosteum. Furthermore, this thin partition of bone is often perforated by quite a large opening, through which passes at least one of the mastoid emissary veins. It is important to remember these relations of the parts as they exist in infancy; for without this knowledge we might experience great alarm over phenomena which, indeed, seem to point to serious disease, but which appear comparatively harmless when interpreted in the light of the anatomical relations which I have just described. The phenomena to which I refer are these: A large swelling develops rather rapidly behind the ear of an infant, who has been fretful and feverish for a few days. There may or may not have been a slight discharge from the are; but if there have been a discharge, it will have ceased before the swelling makes its appearance. From the fluctuation, which is readily discoverable, from the inflamed appearance of the neighboring skin, and from the elevation of the body-temperature, it becomes reasonably certain that the swelling represents an abscess. An incision is then made, and the correctness of the diagnosis is established; the recovery that follows is rapid and complete. I have had the opportunity of examining the ear in two or three such cases, and have satisfied myself that the pathology of these abscesses is simply this: The resistance offered to the pus accumulating in the cavities of the middle ear, happens to be less in the direction of the mastoid integuments than in that of the membrana tympani, and the pus accordingly forces a way for itself in this direction rather than through the tissues of the drum-membrane. The abscess is not, as in adult life, an indication of a severe and unchecked inflammation of the middle ear, but simply a revelation of the peculiarly free communication which happens to exist between the antrum and the outer surface of the mastoid bone. The absence of any marked swelling of the walls of the auditory canal shows clearly, in these cases, that the pus has not travelled outward—as we occasionally see it travel in older individuals—between the bone and the skin of the external meatus.

The anatomical relations of the antrum, in infantile life, have other important bearings of a practical nature. In the first place, the outer bony wall of this cavity is quite easily broken, at this period of life, by moderately firm pressure with some hard instrument. It is therefore easy to penetrate from without into the antrum, whenever the condition of the ear seems to call for such a procedure. In the next place, counter-irritation behind the ear, in quite young children, often produces promptly beneficial effects upon a sluggish inflammation of the middle ear. The explanation of this fact may be sought for in this peculiar nearness of the antrum to the skin covering the mastoid process, and in the intimate vascular and nervous relations that exist between the two regions.

Fig. 899.



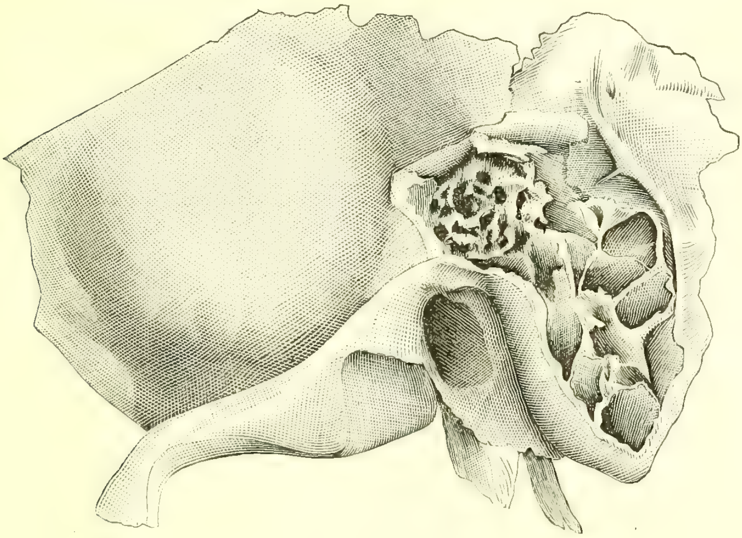
Mastoid process of adult. Transverse, vertical section.

The mastoid process of a child, four or five years of age, already presents all the essential features of that belonging to a full-grown adult. It is smaller, however, and the bone substance is still somewhat less dense and firm than it is in adult life. Even in its fully developed state, the mastoid bone will be found to vary greatly in size in different individuals. I can give no exact measurements, as the limits of the mastoid portion of the temporal bone are not sharply defined. I have a specimen, however, in which the distance between the upper and lower limits of the mastoid cells measures an inch and three quarters, while horizontally the extreme limits are an inch and a quarter apart. This specimen, I am satisfied, must be considered as an unusually large one, for among a number of temporal bones in my possession, I can find no other in which the mastoid cells are of equally great extent. Strictly speaking, the term mastoid process refers only to the lower, teat-like projection of the bone, but in this article, and in fact in medical parlance generally, the expression is intended to refer to all that portion of the temporal bone which contains the honeycombed structure usually found in the mastoid process. This peculiar structure consists of a number of small cavities or cells, which vary greatly in size and shape, not only in the same temporal bone, but also in those belonging to different individuals. Many of these cells, probably the great majority of them, are lined with an extension of the mucous membrane of the tympanum, and communicate one with another. Under normal conditions they contain air, and are therefore spoken of as the pneumatic cells. The remaining cavities are filled with a fatty tissue resembling that which is found in the diploë of fresh bones. Zuckerkandl, who examined one hundred mastoid processes in the fresh state, and one hundred and fifty macerated temporal bones, found that air-cavities were wholly lacking in twenty per cent. of the specimens, and that perfectly pneumatic mastoid processes, without any diploëtic spaces, represented only 38.6 per cent. of the entire number. Furthermore, he ascertained the fact that in some individuals only the lower half of the process was diploëtic, while the upper half was entirely pneumatic. These comparatively recent researches throw a great deal of light upon the pathology of acute and chronic purulent affections of the middle ear. They make it easy to comprehend how in one individual, whose mastoid cells are quite large and communicate freely one with another, an inflammation of the middle ear may, almost at the very onset of the attack, involve the mastoid region, while in another the same disease, in perhaps a far more severe form, will leave this region wholly unaffected. Unfortunately, Zuckerkandl's researches do not show whether we are permitted to consider the absence of pneumatic cells, in the specimens examined by him, as a perfectly natural peculiarity of construction, or whether these spaces may not have been obliterated by an unnatural hypertrophy of the bone, the result of disease.

We must next consider the mastoid cells in their relations to neighboring parts. Superiorly, they may extend as high as to within half an inch of the temporo-parietal suture. In this comparatively thin part of the temporal bone, they are separated on the outer side from the periosteum, and on the inner side from the dura mater, by a dense layer of bone, which varies from one to three millimetres in thickness. Anteriorly, the pneumatic cells extend forward over the external auditory canal. Posteriorly, they cease somewhat abruptly, that is, without any material diminution in size, in the immediate vicinity of the temporo-occipital suture. Hyrtl, according to the authority of Schwartze, found three skulls (among six hundred which he examined for this purpose) in which the pneumatic cells extended even into the occipital bone. I once, in trephining the skull, found pus between the outer and inner tables of the occipital bone, a short distance back of the temporo-occipital suture, and thought, at the time, that it had travelled along the diploëtic spaces from a large abscess which existed in the body of the mastoid process. In the light of Hyrtl's discovery, it now seems to me at least equally probable that the pus found at this remote spot was really lying in pneumatic spaces which stood in direct communication with those immediately surrounding the abscess. The lateral sinus occupies a groove in the bone in the immediate vicinity of the posterior limits of the mastoid cells. Not far from the centre of the irregularly shaped mass of mastoid cells, but much nearer to their inner than to their outer limit, lies a single cavity, known by the name of the "antrum," or "horizontal portion of the mastoid cells," as it is termed by

Toynbee. It opens anteriorly, by a comparatively large mouth, into the tympanum proper. Its floor usually lies at a higher level than that of the tympanum. Its walls present a honeycombed appearance, which is due to the presence of numerous openings leading into the surrounding pneumatic cells. A medium-sized pea would probably fill the antrum. Pneumatic cells are found on the inner and posterior sides of this cavity as well as on its outer side. They also extend to a considerable depth beneath its floor. In fact, they are absent only along the roof of the cavity. At this point a comparatively thin lamina of dense bone, often less than a millimetre in thickness, serves as a dividing partition between the dura mater above and the tympanic mucous membrane below. The distance from the posterior extremity of the antrum to the groove for the lateral sinus, varies from three to six millimetres (see Fig. 899); that from the outer wall of the cavity to the outer surface of the bone, varies from twelve to twenty millimetres (one-half to three-fourths of an inch). In cases of hyperostosis the antrum may be found to lie at even a greater distance from the outer surface of the bone. Finally, there are several points at which the bone surrounding the antrum is pierced by small channels which give passage to bloodvessels and lymph-vessels, and their sheaths of connective tissue. The most important of these are: the petro-squamous fissure, which crosses the bony roof that is common to both cavities (the tympanum and the antrum); and the channels for the mastoid emissary veins, which traverse the bone from within outward. One of these canals commonly opens near the centre of the outer surface of the process, about on a level with the upper wall of the external auditory canal. Minute bloodvessels pass from the mucous membrane of the middle ear to the dura mater by way of the petro-squamous fissure, and by the same route an inflammation may spread from the ear to the brain. The redness, tenderness, and swelling of the mastoid integuments, in cases of inflammation of the

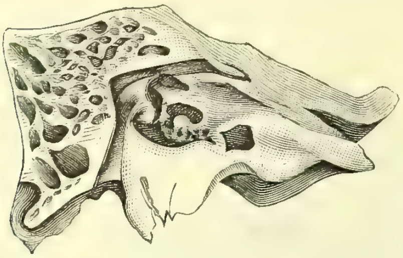
Fig. 900.



Extensive distribution of mastoid cells.

middle ear, may be explained by the assumption that the inflammation has followed the course of the mastoid emissary veins. Finally, I have still to mention the close proximity of the facial canal to the mastoid cells. In the immediate neighborhood of the mouth of the antrum, this canal turns sharply from its previous horizontal course, and passes directly downward through the pneumatic and diploëtic cells of the mastoid bone. It is therefore easy to understand why the facial nerve should be particularly liable to participate in any pathological changes that may take place in the mastoid cells.

Fig. 901.



Relations of facial canal to middle ear proper and mastoid cells; oblique, vertical section of temporal bone.

Although the antrum and the tympanic cavity proper are, to all intents and purposes, one and the same region, and although we have no just grounds for believing that, in an acute inflammation of the middle ear, the larger cavity of the tympanum is much more actively involved in the disease than the smaller cavity of the antrum, we are apt, it appears to me, to entertain this very belief. Our patients would fare better, I am confident, if we adopted the more rational view, and utilized the degree of inflammation presented by the drum-membrane and visible, adjacent parts, as a fairly true measure of that which must at the same time be going on in the antrum. In this connection, however, we must remember that in a few exceptional cases the membrana tympani may show comparatively insignificant evidences of inflammation, and yet an abscess may be present in the adjacent mastoid process. The mechanical relations of the tympanum proper, the antrum, and the pneumatic cells of the mastoid process, exert a determining influence upon the course of the inflammation that may from any cause be excited in them. At almost the very outset of such an inflammation, the only natural outlet which these cavities possess, viz., the Eustachian tube, becomes closed by the swelling of its walls. The conditions then are those of an inflammation taking place in a cavity whose walls, at every point but one, consist of unyielding bone. The membrana tympani represents the only point at which the accumulating products of the inflammation can force a way of escape for themselves. In a few instances the case may be in even a worse plight than that which I have just described. For example, the mouth of the antrum, or the mouths of the numerous pneumatic cavities which open directly into the antrum, may become closed; in which event the establishment of even a very free opening in the membrana tympani would fail to afford an exit for the secretions confined in those more remotely situated cavities. This occurrence is, I believe, not uncommon. The question then presents itself, what is likely to be the succession of pathological events if the products of inflammation are allowed to remain pent up in these cavities? If we possess some knowledge with regard to the individual's previous aural history, we may form a tolerably correct notion of what is likely to take place in these inflamed parts. In an individual who has not been subject to frequent or prolonged attacks of discharge from the ear, we may assume that the pneumatic cells still contained air at the time of the attack. In that case, the inflammatory exudation in the cells will soon change from a mere bloody serum to a thick pus, and, as the pressure increases, the lining mucous membrane of many of the cells will die and break down into purulent detritus. Even the thin bony partitions may soften and become detached. At all events, loose fragments of the bony septa are sometimes found in recent abscesses of the mastoid process. In favorable cases, the pus may burrow a way for itself along one of the emissary canals, and pour its contents into the space between the outer surface of the bone and the periosteum, and through the latter into the cellular tissues behind the ear; or it may travel downward and develop an abscess in the soft parts below the mastoid process, between the skin and the muscles of the neck. In a third series of cases, the pus may work for itself a channel through the mass of bone which separates the floor and anterior part of the antrum from the upper and posterior wall of the auditory canal. Finally, if the resistance in these directions be too great, or if the channels of communication between the antrum and the intra-cranial cavity be unusually free, pus will find its way to the latter region, and will induce either a diffuse meningitis or an abscess in the very substance of the brain. It is possible, also, that in recent cases a carious process may be set up in that part of the bone which lies next to the groove for the lateral sinus, and that ulceration of this vein, with accompanying phlebitis, pyæmia, etc., may result therefrom. This issue, however, is to be looked for rather in chronic cases, in which the main portion of the pneumatic cells has been obliterated by sclerosis.

If a severe inflammation of the middle ear goes on unchecked, in an individual whose previous aural history points to the frequent occurrence or prolonged continuance of a discharge from this region, we may assume, with considerable confidence, that the majority of the pneumatic cells have become obliterated through a process of sclerosis. It will be seen at once that in such an ear the chances of a spontaneous cure are seriously diminished. When the antrum, in such a case, takes on a more acute type of inflammation, and when at the same time its natural outlet becomes obstructed or closed, the confined pus can no longer burrow a way for itself outward through the thick mass of ivory-like bone. The bony roof of the antrum is then likely to become carious, and the pus finds an outlet in this dangerous direction. Or the mass of bone which separates the antrum from the lateral sinus, and which, I believe, is largely composed of diploëtic spaces, breaks down under the effects of caries, and then the fatal issue is not long delayed.

In addition to these destructive forms of inflammation of the mastoid process, there is one which partakes rather of the nature of hypernutrition of the bone. To this form, which leads to the condition known as *sclerosis of the mastoid cells*, we shall give the name of *condensing osteitis of the mastoid process*. This type of mastoid inflammation has now been accepted, thanks chiefly to the writings of Dr. J. Orne Green, of Boston, as a fairly distinct disease, characterized by certain well-marked symptoms, and requiring, for the relief of the most prominent of these, a particular therapeutic procedure. A chronic hyperæmia of the mucous membrane lining the pneumatic cells, and also of the vascular connective tissue that fills the diploëtic spaces, undoubtedly constitutes the essence of this osteitis. A chronic inflammation of the mucous membrane of the tympanum proper, and of the antrum, furnishes the provocation for this hyperæmia. Increase in the amount of bone follows this chronic hyperæmia, and in the course of time this increase may even go so far as to obliterate the pneumatic spaces entirely. The constantly increasing pressure exerted upon the mucous membrane lining these spaces, explains the severe pain experienced by patients who are affected with this disease.

A *periostitis* of the mastoid process is always, I believe, to be interpreted as the result of direct violence (a blow or a fall), or as an extension of an inflammation, located either in the external auditory canal or in the mastoid cells. I have never seen anything that I could consider as a primary, idiopathic, mastoid periostitis, although such a disease has been described by different writers on otology.

In actual practice we find that no two cases of mastoid disease are exactly alike. At the same time, it is not a difficult matter to distinguish among them a few groups, in each of which there are certain distinguishing features which belong to the members of the group in common. Formerly I made a subdivision of these cases into five groups, but I am satisfied now that it is a better plan not to recognize more than three types of mastoid disease. They are as follows: (1) Subacute, condensing, mastoid osteitis; (2) Acute, diffuse, mastoid osteitis; (3) Chronic ulcerative inflammation of the mastoid antrum. These three groups differ materially from the three classes into which I have divided mastoid affections in my work on ear diseases. It is my belief and hope that this new subdivision, which simplifies the subject considerably, will enable the practitioner to arrive more quickly and surely at a correct diagnosis.

SUBACUTE CONDENSING MASTOID OSTEITIS.—(*Sclerosis or Hyperostosis of the Mastoid Process.*)—It is only a short time since the independent nature of this affection has been made known to us. It owes its origin to a chronic purulent inflammation of the antrum and other parts of the middle ear, but it may continue as an active disease for some time after the exciting cause has been removed. In very many cases it probably runs its course without giving rise to any decided symptoms, but in other instances severe pain and outward evidences of mastoid periostitis accompany the disease and reveal its existence to us. The protracted, subacute inflammation of the mucous membrane which lines the pneumatic cells, and also probably of the connective tissue which fills the diploëtic spaces, leads to the gradual filling up of both these cavities with bone substance. This form of osteitis rarely comes before us as a disease requiring treatment. It usually assumes importance when we are called upon to investigate and treat the other varieties of mastoid disease. The question is then sure to present itself: What is the condition of the mastoid cells which lie between the antrum and the outer surface of the bone? The following rule may safely guide us under these circumstances: If the history of the case reveal the previous existence of chronic purulent inflammation of the middle ear, we may assume that the mastoid cells have been greatly reduced in size, if not obliterated, by earlier attacks of subacute osteitis. In the few cases of condensing osteitis which are likely to come under our observation because they require treatment for the disease itself, we may very readily be led into the error of supposing that we are dealing with a case in which the essential lesion is an acute, diffuse, mastoid osteitis of a serious nature. The pain is sometimes so severe that no other diagnosis seems possible. Under these circumstances, we may be guided by the following considerations: If the case be one of simple, condensing, mastoid osteitis, our attention cannot fail to be drawn to the persistence of decided pain in and around the mastoid region, despite the existence of an adequate outlet in the drum-membrane for the pus secreted in the middle ear, despite the absence of anything like an acute inflammation of the middle ear or external auditory canal, or, finally, despite the employment of such therapeutic measures as would be likely to allay any ordinary inflammation of the mastoid structures. Furthermore, if, in addition to the pain, there be redness, tenderness, and swelling of the mastoid integuments—in the supposed case which we are now considering—these manifestations must be interpreted as furnishing corroborative evidence of the existence of a persistent, subacute inflammation of the underlying bony structures. Actual enlargement of the bone itself may be considered as furnishing almost positive proof that the mastoid cells have been obliterated, or are still being obliterated, by a process of hyperostosis.

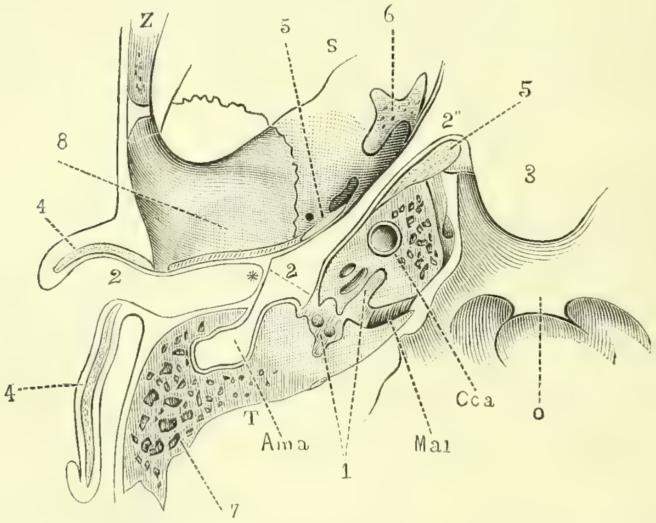
As far as the affection itself is concerned, the *prognosis* is by no means bad. The obliteration of the mastoid cells by the conversion of all this part of the mastoid process into solid bone, is apt to do harm only in two ways: It shuts off the possibility of a spontaneous cure in the event of the development of serious inflammation in the antrum; and it is also apt to prevent the development of those outward evidences which afford so valuable a warning of the existence of deep-seated disease in this part.

Treatment.—Hot poultices, leeches, and even Wilde's incision, will probably fail to give more than temporary relief. If such prove to be the case, and if the pain continue unabated, we should not hesitate to resort to perforation of the painful bone, with a drill or other suitable instrument. One opening will probably suffice, provided that it be carried to a depth of fully half an inch. As the beneficial effects of this operation, in a case of this nature, depend not upon the establishment of an outlet for pent-up products of inflammation, but rather upon the derivative effects exerted by such a wound in the bone, no effort need be made to reach the antrum. A straight, vertical incision may therefore be made through the mastoid integuments, and the point of the drill may be applied as far in front of this line, on a level with the upper wall of the meatus, as the stretching of the divided periosteum will permit. The healing of the wound may be delayed to advantage, by inserting into it a tent of sheet-lint, well anointed with carbolated vaseline. At the end of twenty-four, or at the most forty-eight hours, the tent should be removed. In addition to these measures, which are directed more particularly to the osteitis, we must not neglect to do whatever may be found necessary for the relief of the disease which involves the middle ear proper. The systematic cleansing of the antrum, by means of the douche, will often be found to serve an excellent purpose in these cases, though as a matter of course the local conditions may not always be such that we can resort to this procedure.

ACUTE DIFFUSE MASTOID OSTEITIS.—This variety of mastoid disease includes all the different degrees of inflammation which may develop in a previously healthy mastoid process. A widespread congestion of the antrum and pneumatic cells represents, therefore, the simplest type. The inflammation may cease spontaneously, or may be arrested by therapeutic interference, when it has reached this stage, and the parts may then gradually return to their normal condition. However, if the inflammation continue, both the antrum and the pneumatic cells will soon be filled with exudation, and whatever be the character of this exudation at first, it is sure before long to become distinctly purulent. I think it possible that, even after the disease has reached this advanced stage, a spontaneous recovery may still, under favorable circumstances, take place, without the formation of an abscess in the bone. I may mention, as one of these favorable circumstances, the sudden escape of part of the exudation, through one of the channels which naturally give passage to the mastoid emissary veins, into the soft parts on the side of the neck. It is more likely, however, that the disease, if left to itself, will pass from this second stage into a third, which is characterized by the death of some part or parts of the mastoid process. Pressure continued beyond a certain period is sure to result in the death of the mucous membrane pressed upon; and, in the case of the pneumatic cells, the mucous membrane is probably the only source of nourishment which very many of them possess. Hence the death of those bony septa which have been deprived of their periosteal coverings. Softening and disintegration of the bone follow next in order, and, if the pressure continue, we may expect the area of dead bone to increase. In cases belonging to this second group of mastoid affections, this progressive death and ulceration of the bone are fortunately somewhat more likely to follow an outward course toward the skin than an upward direction toward the brain, or a backward one toward the lateral sinus. In this way a spontaneous cure has often taken place, the pus finding an outlet through a carious channel in the outer part of the mastoid bone. I have said that such a favorable issue is somewhat more likely to take place than the fatal one which is sure to follow ulceration either toward the lateral sinus or toward the brain, but I base my statement simply on an impression, and consequently I may easily be in error with regard to this point; and it is at least certain that the fatal cases belonging to this second group are numerous enough to warn us against trusting very much to the chances of spontaneous cure.

The *symptomatology* of this form of mastoid disease is at first precisely the same as that of an ordinary, acute, purulent inflammation of the middle ear. The pain, however, shows a marked tendency to persist, even when active measures are adopted for the purpose of alleviating it, and is apt gradually to involve the entire side of the head. Usually there is a moderate elevation of the body-temperature, though I have known even this symptom to be lacking. In a boy of eighteen, I once noted, just before establishing an artificial opening in the mastoid bone, a temperature of 105° Fahr. This is the highest temperature that I have ever observed in a case of acute inflammation of the ear. It fell to 99° F. soon after the operation. Redness, tenderness, and swelling of the skin covering the mastoid process, indicate the existence of a mastoid periostitis; and the development of a mastoid periostitis, in the progress of an undoubted acute inflammation of the middle ear, admits of only one interpretation, viz., it indicates the existence of an inflammation of

Fig. 902.



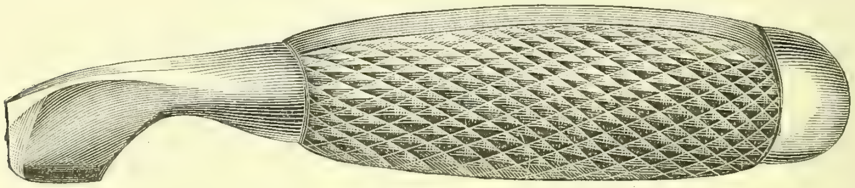
Henle's diagram showing relations of all parts of the temporal bone to each other. 1, Various cavities constituting the labyrinth; 2, External auditory canal; 2′, Tympanum; 2″, Pharyngeal mouth of the Eustachian tube. 3, Vault of pharynx. 4, Cartilaginous framework of auricle. 5, Inner cartilaginous lip of orifice of Eustachian tube; 5′ Cartilaginous plate at tympanic orifice of Eustachian tube. 6, Pterygoid process of sphenoid bone. 7, Mastoid cells. 8, Glenoid fossa of temporal bone. * Membrana tympani. A m a, Mastoid antrum. C c a, Carotid canal. M a i, Meatus auditorius internus. O, Basilar process of occipital bone. S, Sphenoid bone. T, Temporal bone. Z, Zygoma.

the mastoid cells. Unfortunately, it does not indicate how far the inflammation has progressed, but this important fact can be ascertained approximately in other ways. For example, the degree of redness and swelling of the upper and posterior cutaneous wall of the auditory canal, in the neighborhood of the membrana tympani, furnishes a safe criterion of the activity of the inflammation in the antrum. A glance at Fig. 902 will show how near the cavities are to each other at this point. The duration and severity of the pain, both in the mastoid region and throughout the entire side of the head, must also be remembered when we are endeavoring to decide in our minds what is the exact condition of the mastoid structures. In the presence, therefore, of well-marked mastoid periostitis, of decided redness and appreciable swelling of the skin along the posterior and upper wall of the meatus, close to the drum-membrane, and of a history of pain behind the ear and throughout the entire side of the head for a period of not less than one week, we may unhesitatingly assume that the inflammation of the antrum and pneumatic cells has reached a stage in which pus has certainly formed in the antrum, and probably in many of the pneumatic cells. If a prolapse of the posterior and upper cutaneous wall of the meatus has already taken place, we can feel confident that the disease has gone even farther, and that caries is liable to ensue at any time if it have not already occurred. This drooping or separation of the skin from that portion of the bony wall which serves at the same time as the floor or anterior wall of the antrum, indicates a high degree of inflammation in this particular region of bone; and if the adjacent body of the mastoid process is still pneumatic—and, in the class of cases which we are now considering, we have a right to assume that it is still in that condition—it is scarcely conceivable that it should not be participating, to a more or less marked degree, in the inflammation.

Treatment.—The moment we have gained a reasonably clear conception of what is the nature and extent of the disease which we are called upon to treat, the course which we ought to pursue lies clearly marked out before us. We should ask ourselves, first, this question: Is the outlet for the discharge, by way of the external auditory canal, as free as it can be made by any reasonable operative interference? If obstructions still remain—if granulation-growths or masses of epidermis and pus block the way, or if the opening in the membrana tympani be too small—these hindrances should be removed. Our next question should be: To what stage has the inflammation of the mastoid structures progressed? If we have reason to believe that the parts are simply congested, we may trust to the application of from two to five leeches, according to the age and strength of the patient, and afterward to a thoroughly carried out system of hot poulticing. The leeches may all be applied directly over the mastoid process, or some of them may be applied at that point and the others directly in front of the outer orifice, as close as possible to the tragus. Rest in bed is a far more important feature of the successful treatment of these acute affections of the ear than very many of us suppose. On the other hand, if our minds are somewhat in doubt about the wisdom of trusting to these simpler and less powerful measures, or if we have tried them and they have failed to relieve the pain, we should promptly resort to a "Wilde's incision." In this operation, the skin and subjacent tissues, including the periosteum, are divided by an incision extending from the base very nearly to the apex of the mastoid process, the external wound measuring from three-fourths of an inch to an inch in length. If the patient's head is in the erect position, the point of the knife should be introduced into the skin about on a level with the upper wall of the external orifice of the auditory canal. If we begin the incision higher up, we shall be apt to divide a branch of the posterior auricular artery, which usually crosses the bone at about that level. On the other hand, if we make the incision a little too far forward, we may nick this artery or incise it longitudinally, and so prepare the way for the development of a false aneurism, as has already twice happened, once in my own practice and once in that of Dr. Charles J. Kipp, of Newark, N. J. After the bleeding from the wound has ceased—and, within reasonable limits, the more protracted and the more copious the bleeding, the better—I usually introduce a small tent well-smeared with vaseline, for the purpose of preventing the wound from healing by first intention. Hot flaxseed-meal poultices should then be applied to the mastoid region as often as may be found necessary to keep the parts warm and moist. As Sir William Wilde, of Dublin, Ireland, was the first to call attention to the decided, restraining influence which such deep incisions of the mastoid integuments exert upon an inflammation of the body of that bone, it is eminently proper that the name of "Wilde's incision" should be retained for this most efficient therapeutic procedure.

Finally, in those cases in which the pain has persisted steadily for several days, and has perhaps resisted all the measures that may have been adopted for its relief—and in which all the local signs point quite clearly to a serious degree of inflammation in the body of the mastoid process—we should proceed without further delay to establish a broad opening in the outer part of this bony prominence. The steps of this operation, which ordinarily must be performed with the aid of an anæsthetic,[1] are as follows: First, the outer surface of the mastoid bone must be laid bare. Formerly I was in the habit of doing this by means of a longitudinal incision, which terminated below at the tip of the process. I found, however, that in pushing the periosteum forward, so as to lay bare the bone in the vicinity of the meatus, I encountered a troublesome degree of resistance on the part of this strong fibrous sheath. My present plan is to make an obtuse-angled or crescent-shaped incision, of which the upper end begins above the meatus, in the hairy scalp (which in this region must first be shaved), while the lower end reaches nearly to the tip of the process. If this sort of an incision be made, no difficulty will be experienced in pushing the periosteum forward, and in exposing the surface of the process fully to view. If the periosteum adheres firmly to the underlying bone, I find it desirable to employ a strong, dull-edged knife such as is represented in Fig. 903. If the bone be found softened at any point, the attempt should be made to break through it at this spot, and thus complete the work which nature has begun. The outer surface of the bone, however, is usually found to present a normal appearance. Under such circumstances, the drill should be applied to the bone at a point about a quarter of an inch distant from the orifice of the canal, and a little below the level of its upper wall. The instrument should then be rotated in a direction inward, a little forward, and a little upward, that is, in a direction nearly

Fig. 903.



Strong periosteum knife.

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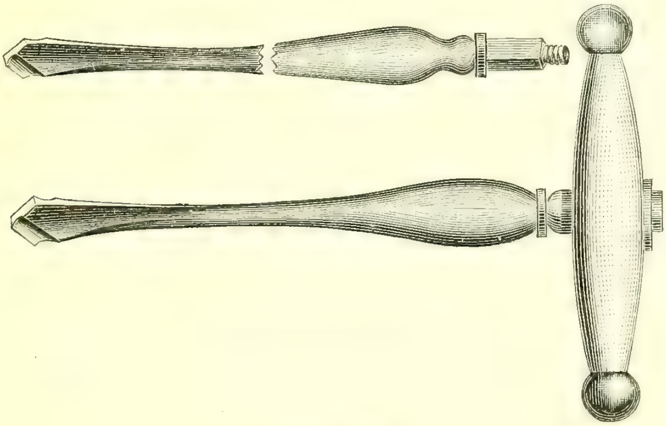
[1] In three instances I have, at the patient's earnest request, performed the operation without the aid of an anæsthetic.

parallel with the auditory canal. The forefinger of the hand which guides the drill should rest firmly against the bone. If this precaution be taken, there will not be the slightest danger of our suddenly plunging the sharp point of the drill into parts which might thereby receive serious damage. The instrument should be constructed in such a manner that its cutting edges shall be turned in opposite directions. The accompanying figure shows this feature of the instrument very clearly. An operator whose fingers are unusually short, might perhaps find the drills a little too long; in which case he would find it necessary to have them shortened. When the drill has penetrated into the bone to an appreciable distance, it should be withdrawn, and the exact depth of the opening should be ascertained. After a few more turns of the instrument have been made, the depth should be measured a second time. The antrum should be reached at a depth not exceeding three-fifths of an inch. My rule is, never to force the instrument beyond a depth of twenty millimetres, or three-quarters of an inch. Schwartze, of Halle, in Germany, who has probably had more experience in this class of cases than any other surgeon living, places the extreme limit at twenty-five millimetres. When the end of the drill reaches the pneumatic cells, we must manipulate it more carefully, as our object is to establish a cylindrical outlet, and not to break down the cell walls throughout a large area. I always begin the operation with the larger drill, and then employ the smaller one, when I find that I am in danger of using too great leverage force. In this connection I should state that it has been ascertained by experience that, in very many cases, it is sufficient to carry the drill simply far enough inward to reach one or more of the pneumatic cells. I have repeatedly stopped short of the antrum, in operating upon the mastoid bone, and in all these cases I have obtained as perfect results as I have in those in which the opening was made to terminate directly in that cavity. Such a favorable issue is to be attributed, in some cases, to the fact that in establishing a communication between the outer air and some of the pneumatic cells, we have in reality established a communication—somewhat indirect, it is true—with the antrum itself. In other cases, the benefit derived from this incomplete operation can only be explained on the assumption that the establishment of a new centre of inflammation, in close proximity to that which has hitherto been the real centre of disease, produces a strongly derivative effect, and so checks the progress of the fundamental malady. Whether these speculations about the

Fig. 904.



Mastoid drills.

mode of action of this operation be true or not, the fact is now well established, that through its instrumentality patients experience prompt relief from pain, and that the disease is rapidly brought under control, and in due time cured.

If a collection of pus is reached, in the course of the operation, we should search carefully for loose fragments of bone, and should remove them with the forceps, if any be found. Then, before dressing the outer wound, we should wash out the channel in the bone, or the antrum, as the case may be, with a five-per-cent. solution of carbolic acid. In carrying out this procedure, it is well to employ a nozzle or tube that is smaller than the artificial channel, so as to allow room for the return current to find a free outlet by the side of the instrument. At first no attempt should be made to approximate the widely separated edges of the wound. The more open the outer wound, the more easily shall we be able, at the daily dressing, to cleanse the deeper cavities. As an outside dressing we may apply, first, a suitable patch of lint well smeared with carbolated vaseline. Then outside of this, during the first twenty-four hours, flaxseed-meal poultices should be applied at short intervals of time. After the first day, the channel in the bone, or the antrum, as the case may be, should be thoroughly washed out once a day with either a warm, saturated solution of boracic acid, or a weak (two-per-cent.) solution of carbolic acid. When the outer wound so far heals up that the nozzle of the douche can no longer be introduced into the opening in the bone without causing the patient considerable pain, this part of the treatment may be omitted. I have known the outer wound to close permanently as early as on the tenth day after the operation. Then again, I have known it to remain unclosed for a period of several months.

Chronic Ulcerative Inflammation of the Mastoid Antrum.—From this class of mastoid affections, come probably the greater number of fatal cases of ear disease. Through a period of months or, more commonly, of years, the patient is affected with a chronic discharge from the ear. The underlying disease begins as a simple purulent inflammation of the middle ear, and then, in the course of time, usually through the instrumentality of an obstructed outlet, the solid elements of the discharge—pus-cells, epithelium, detritus, cholestearin-crystals, etc.—begin to accumulate in the antrum. While these changes are taking place, the mastoid cells are being steadily reduced in size by a chronic osteitis, and, by the time that the accumulating solid matters have filled the antrum, the mastoid process will be found to have reached the condition of complete sclerosis. Ulceration of the walls of the antrum, in whatever direction the least resistance is met with, follows surely upon the formation of one of these foul-smelling masses of cheesy material in that cavity. The directions in which the resistance is least are, first, upward toward the brain, and next, backward toward the lateral sinus. In one or both of these directions, therefore, a destructive carious process may be expected to take place, if a vent be not established by artificial means sufficiently early to prevent such an issue.

In this variety of mastoid disease, pain, at times severe, is the most prominent symptom. While in the previously described variety external evidences of the underlying mastoid disease are rarely wanting, in this form of the disease they are rarely present, and then only when the disease is far advanced. On the other hand, one can usually find unmistakable evidence that the outlet through which the pus has been escaping from the middle ear into the auditory canal, is too narrow to permit the discharge to escape freely from the more deeply situated cavities. The persistence of pain, therefore, under such circumstances, becomes a very important indication—in fact, often the only indication—of the severity of the deeper-lying ulcerative inflammation. If we wait for the development of additional manifestations of this treacherous disease of the antrum, before taking active steps to check it, we may rest assured that in many cases we shall let slip the golden opportunity of saving the patient's life.

Cases are now and then encountered in which, by skilful interference, we may succeed in clearing the antrum of its foul contents, and in re-establishing a free outlet for the secretions that constantly accumulate in it, without boring through the outer portion of the mastoid process. As a rule, however, this is not practicable, and in one case I am confident that my efforts to accomplish this difficult task only resulted in adding to the existing pain, and in hastening the fatal issue. In a general way, we may say that this form of mastoid disease admits of only one safe and effective plan of treatment, viz., that which consists in the establishment of a free channel of communication between the antrum and the outer air, through the mastoid process. The drill must be carried down actually to the antrum, and not merely to some still open pneumatic cell, if such should be found.

In the preceding description of mastoid diseases, I have been careful to portray only uncomplicated, well-defined types of these affections. I will now recapitulate very briefly the main, distinctive features of these diseases, in the hope of rendering this branch of the subject still clearer. The first variety of the mastoid disease—subacute, condensing, mastoid osteitis—is really nothing but an accompaniment of an ordinary, chronic, purulent inflammation of the middle ear. It does not immediately threaten either the life or the health of the patient. It may not even cause pain, and under such circumstances we are not likely even to have our attention drawn to the fact that the disease is present. In a few instances, the single symptom of pain becomes a prominent feature of the disease—so prominent, indeed, that we may be obliged to resort to the operation of boring into the mastoid bone in order to secure for the patient the desired relief. Here then we have a well-defined and very important type of mastoid disease. But its importance does not cease here. The chief result of this condensing osteitis is the obliteration of the pneumatic cells of the mastoid process. In ulcerative disease of the antrum, therefore, this condensing osteitis plays an important part. It commonly prevents the development of certain symptoms which are of great diagnostic value, and at the same time it interposes a solid wall of bone between the cavity of the antrum and the outer air, thereby greatly enhancing the serious character of an ulcerative inflammation of that cavity.

The second and third varieties differ in these respects: in the former, the pneumatic cells participate in the inflammation of the antrum, while in the latter they play no part as a separate system of cavities, but a very important one as a wall of bone impenetrable to ulcerative processes. In acute, diffuse, mastoid osteitis, we can generally limit our operative interference to the establishment of a free communication between some of the pneumatic cells and the outer air; while in chronic, ulcerative inflammation of the mastoid antrum, we must carry the artificial canal down to this cavity.

Significance of Certain Phenomena occasionally met with in Diseases of the Mastoid Process.—In addition to the symptoms described above, there are others which occur more or less frequently in affections of the mastoid process, and which should at least receive mention in these pages. Thus, for example, partial or complete paralysis of the facial nerve often develops during the progress of either the second or the third form of mastoid disease. It is probably brought about by the pressure of an effusion that has been poured out into the bony canal through which the facial nerve passes. That such an effusion should take place, shows that the inflammation of the bone in the vicinity of the antrum has reached a serious degree of activity. The symptom is therefore of decided diagnostic value. In some cases permanent paralysis remains after the mastoid disease has entirely subsided, while in others every trace of the paralysis disappears in the course of a few weeks.

Sometimes the tissues on the side of the neck, a short distance below the tip of the mastoid process, become inflamed, and swell rather rapidly into a hard, flattened, and very sensitive tumor. The skin covering this matted cake of inflamed glands and other soft parts lying outside of the muscles of the neck, is red, œdematous, and firmly adherent to the underlying tumor. I have sometimes observed that the development of such a swelling takes place simultaneously with a decided subsidence of the pain in the mastoid region and side of the head, and for this reason I have been disposed to believe that some of the acrid secretion contained in the antrum or pneumatic cells, must have found a way of escape through one of the canals for the mastoid emissary veins, thus diminishing the degree of pressure within the mastoid process, and at the same exciting, by its acrid properties, a sharp inflammation of the tissues into which it first escaped. It is also possible, as suggested by Dr. J. Orne Green, of Boston, that a phlebitis of one of the mastoid emissary veins may be the cause of such a swelling of the soft parts below the mastoid process. By the frequent application of hot flaxseed-meal poultices, I have known such swellings to disperse without the development of an actual abscess. However, if pus forms, the knife must be used.

In several cases I have observed the development of an abscess, or at least of a circumscribed area of inflammation, in some part of the scalp of the corresponding side of the head. I believe that any part of the scalp may become the seat of such an abscess, or of such a localized inflammatory swelling, as I have encountered them in very different regions, viz., in the vicinity of the occiput, on the very top of the head, midway between the top of the head and the mastoid region, and in the temporal region. It seems to me reasonable to suppose that the lymphatics carry some of the acrid secretions from the mastoid cavities to these different localities, thus starting, by transportation, new centres of inflammation. In opening such abscesses I have sometimes been annoyed by the profuseness and obstinacy of the bleeding.

As a rule, the body-temperature may be taken as a measure of the activity of the disease in the mastoid process. This is particularly true of youthful subjects. In adults, however, we must not allow ourselves to be lulled into a sense of security by reason of the absence of noticeable fever. In one of my cases, which terminated fatally (probably from abscess of the brain), the temperature, during the last thirteen days, did not once rise above 100° F. Delirium does not necessarily indicate a fatal issue. Coma and strabismus, on the other hand, are more grave symptoms, for they point clearly to the development of intra-cranial processes which are quite likely to terminate in death.

Fractures of the Temporal Bone.

As the subject of fractures of the temporal bone is considered in the article on Injuries of the Head, I shall confine myself in this place to a very brief presentation of those aspects of the subject to which the general surgeon as a rule pays very little attention. The so-called "fractures at the base of the skull" probably always involve the temporal bone. These cases do not often come under the observation of the aural surgeon, and the medical man first called to see the case probably never thinks of making an examination (with the speculum and reflected light) of the external auditory canal and drum-membrane. Hence our supply of facts with regard to the lesions demonstrable during life in the temporal bone of a person who is believed to have a fracture at the base of the skull, is very scanty. It is sufficient, however, to justify the following deductions.

Fractures of the temporal bone may be subdivided into two classes:—

1. Fracture or diastasis of the tympanic or squamous portion, in the region of the middle ear, without implication of the pars petrosa.
2. Fracture of both the tympanic and the petrous portions.

Both of these kinds of fracture are produced, not by direct violence to the parts, but by *contrecoup;* that is, the patient, in falling, strikes upon the back or the top of his head, while the fracture occurs at the base of the skull. In the first variety, the line or lines of fracture correspond with the lines of union of the three bony portions which together form the temporal bone, and which in fœtal life represent separate centres of growth, viz., the squamous portion (together with the zygoma), the tympanic portion (annulus tympanicus), and the petrous portion (together with the mastoid process). These fractures, therefore, partake somewhat of the nature of diastases. In the second variety, the fracture of the petrous portion of the temporal bone represents a genuine fracture. It takes place in the middle part of the bone, where it is greatly weakened by the presence of several large cavities (the meatus auditorius internus, the cochlea, the vestibule, and the semicircular canals), which are separated one from another by comparatively thin partitions of bone. While it is possible that a fracture may take place in the petrous portion of the temporal bone without a contemporaneous fracture or diastasis in the adjacent squamous or tympanic portion, we possess no facts as yet which will justify such a belief. In fact, the general surgeon is not in the habit of recognizing even two subdivisions, such as I have here made. Now I am satisfied that these subdivisions are by no means fanciful, but rather the reverse: they are eminently practical. Let me illustrate. A person falls or receives a blow upon the head. Bleeding from the ear follows, and may even be copious in amount. He is unable to hear the ticking of a watch in the affected ear, and, when the good ear is closed, he finds difficulty in distinguishing spoken words. The general surgeon, if he make the attempt to locate the fracture without resorting to an examination of the ear, will be very likely to make this diagnosis: fracture of the temporal bone through its petrous portion; a diagnosis which almost necessarily implies the permanent loss of the hearing of the corresponding ear. On the other hand, an examination of the ear with the speculum and reflected light might show a fracture running along the Glaserian fissure, and a tympanic cavity filled with blood. By aid of the tuning-fork, the fact might also be learned that the sonorous vibrations of this instrument were heard best in the affected ear. The diagnosis would then have to be made of a fracture involving the squamous and tympanic portions, and not the petrous; and the patient could properly be encouraged to hope for a partial, if not a complete, restoration of the hearing. Furthermore, the knowledge gained by such an examination of the ear would be likely to materially modify the treatment that would otherwise be adopted.

There are still other phenomena with regard to which the general surgeon is more than likely to form an erroneous opinion, if he do not take advantage of the light which an examination of the ear is competent to afford him. I refer particularly to two symptoms, viz., hemorrhage from the ear, and a watery discharge from the same region. In cases of fracture of the temporal bone, a hemorrhage from the ear means, as a rule, a rupture of the bloodvessels in the vicinity of Shrapnell's membrane. Such a hemorrhage may be copious, and may continue for a comparatively long time; and the mere fact of its copiousness does not indicate that a communication has been opened between the cavity of the tympanum and any of the large vascular channels which surround the temporal bone. I am convinced, from actual observation in numerous cases, that the bloodvessels in the neighborhood of Shrapnell's membrane, are amply able, under favorable circumstances, to provide both a copious and a prolonged bleeding. I am also satisfied, from examinations which I have made in cases of injury to the head of recent occurrence, that fractures of the temporal bone often occur without the slightest bleeding from the external auditory canal. That these views, however, are at variance with those of the best surgical authorities, may be gathered from the following statement, which I have copied from Sir Prescott Hewett's remarks on Fractures of the Base of the Skull, in Holmes's System of Surgery:—

> "Bleeding from the ears, in severe injuries of the head, has, for many years past, been held, and deservedly too, as one of the most valuable diagnostic signs of fractured base. But this bleeding, to be of any value as a means of diagnosis, must be of a serious nature, and, above all, it must continue for some time. With such a bleeding it may be safely diagnosed that there is a fracture of the base running through the petrous bone, and opening up a communication between the cavity of the tympanum and some of the numerous and large vascular channels which surround this bone, or with an extravasation of blood within the cranium itself."

The other symptom, which is considered to be of so great diagnostic value in cases of suspected fracture of the temporal bone, is that of a watery discharge from the external auditory canal. While our direct knowledge with regard to this symptom is almost a blank, apparently no examinations having been made of the ear in suitable cases, a general knowledge of ear-diseases and of the anatomy of the temporal bone would prevent me from accepting in their entirety the views put forward by Sir Prescott Hewett in the following paragraphs, taken from the article quoted above:—

> "There are, then, as far as is known at present, three classes of cases of this watery discharge. In the first class, where the fluid from the ear is plentiful and of a decidedly watery character immediately after the accident, there need be no doubt as to the nature of the injury—the watery discharge is due to the escape of the cerebro-spinal fluid, which, as already stated, can only take place through a fracture of the petrous bone implicating the internal auditory canal and its membranes.
>
> "In the second class of cases, characterized by a copious and prolonged bleeding from the ear, followed by a watery discharge, a fracture of the petrous bone may also be safely diagnosed; but it cannot be said that the fracture follows any particular course. In these cases it must, however, be clearly understood that it is not to the watery discharge that we can trust for our diagnosis, but to the copious and prolonged bleeding.
>
> "Thus far there is no difficulty. Not so, however, in the third class of cases, in which there is at first a discharge of blood only, neither copious nor prolonged, which is followed by a watery discharge, varying as to the time of its appearance—varying as to its quantity. It may be present within a very few hours after the accident—it may be profuse within a few hours after its appearance. These are the cases in which experience has of late proved that the diagnosis ought to be doubtful. The discharge of blood is certainly not of a character to warrant a diagnosis of fracture of the petrous bone; and as to the watery discharge, it is now well known that such a discharge may occur within a few hours after the accident, that its quantity may even be profuse, and yet there may be no fracture."

I may be in error with regard to this matter, and yet it appears to me to be a very simple problem, at least as far as the existence or non-existence of a fracture is concerned. To determine the full extent of the fracture, is quite another matter; although even here, as I have said before, it is easily possible to define rather coarsely the parts of the temporal bone affected. If we consider for a moment the solid, masonry-like construction of the temporal bone, we can scarcely resist the conclusion that, when a blow upon the top, back, or opposite side of the head is followed by any decided symptom whatever in the ear (as, for instance, bleeding, a watery discharge, or even simply pain), a fracture or a diastasis must have taken place in the corresponding temporal bone. A mere jar of the head is not competent to produce a hemorrhage from the external auditory canal. On the other hand, an actual stretching of the soft parts to such a degree as to tear one or more bloodvessels, is not, under such circumstances, physically possible in the vicinity of the drum-membrane, unless at the same time there shall have been an actual giving way of some part of the surrounding arch of bone. Such a laceration of the parts is sure to be followed by inflammation, and this inflammation will be proportionate to the degree of damage done to the parts. A profuse, and sometimes long-continued watery discharge from the middle ear, by way of the external auditory canal, is a well-known characteristic of an ordinary, non-traumatic, acute inflammation of the middle ear, provided that an opening has been established, either by natural or by artificial means, in the membrana tympani. In the severer cases of fracture of the temporal bone, the drum-membrane is very apt to be lacerated, and it is in precisely these severe cases of fracture that we encounter this symptom of a watery discharge from the ear. In estimating, therefore, the diagnostic value of a watery discharge from the ear, in cases of fracture of the temporal bone, I am disposed to go no farther than this: it affords a good measure of the degree of damage done to the temporal bone and contiguous parts. It is by no means necessarily a fatal symptom, for I have known several such cases to recover. I should perhaps not be justified in insisting that all of this watery discharge came from the middle ear and parts bordering upon it. Such, however, appears to me to be the more rational belief.

The treatment ordinarily employed to arrest an acute inflammation of the middle ear, is the treatment that can best be adopted for the relief of the inflammation caused by the fracture. I do not see why it may not, in certain cases, turn the scale in favor of recovery.

Miscellaneous Conditions of the Ear.

In our examinations of the ear, we often encounter conditions which in part represent the final results of some of the diseases described in the preceding chapters, and in part are quite distinct from those diseases. It is, therefore, simply as a matter of convenience that I bring some of the more important of them together here under the title of Miscellaneous Conditions.

Atrophy of the Membrana Tympani.—The membrana tympani may undergo atrophy through the operation of two very different causes; and, in harmony with these etiological differences, we may distinguish two well-marked types of atrophy. In one form, continued atmospheric pressure upon the outer surface of the membrane, without an equally great counter-pressure (also atmospheric) upon the inner side, produces a progressive, symmetrically distributed, and sometimes very marked atrophy of all its constituent parts. The inextensible, radial fibres of the *substantia propria* undergo absorption, in well-marked cases, and as a result we may find the drum-membrane spread out, like a thin film, over the long process of the anvil, the head of the stirrup, and the inner wall of the tympanic cavity. In the slighter grades, the membrane simply appears to be more hollowed out or sunken than it should be, and, according to the degree of congestion of the mucous membrane of the middle ear, and to the presence or absence of fluid exudation in the drum-cavity, its color may be either of a reddish or purplish tone, or simply of a dark, greenish hue. Such a membrane, when inflated by Politzer's or Valsalva's method, will instantly change its entire appearance; becoming as convex, on the side towards the observer, as it before was concave. As the air encaged in the middle ear escapes by way of the Eustachian tube, we can see the membrane recede to or beyond its natural position. Another change will also attract our attention; the surface of the membrane, perfectly smooth and polished while in its sunken condition, becomes dull and sometimes even creased after it has been inflated. Sometimes, under too forcible an inflation, the membrane ruptures. Enlarged tonsils and a well-marked naso-pharyngeal catarrh are probably always associated with this condition of the membrana tympani. If we fail to find them, we may well doubt the correctness of our diagnosis. Such an atrophied drum-membrane is precisely like a newly-produced or "cicatricial" drum-membrane. It is now a well-established fact that the membrana tympani may, through the ulcerative action of disease, be totally destroyed, and then, afterward, upon the return of the region to a healthy condition, an entirely new membrane may be re-created. The latter, however, lacks the unyielding character of the normal drum-membrane, by reason of the fact that the inextensible radial fibres are not reproduced, except perhaps to a very limited degree. A careful inquiry into the previous history of the case can alone enable us to decide which of the two conditions is the one under observation.

In the second form of atrophy of the membrana tympani, the picture presented is markedly different from that observed in the form just described. The membrane occupies a perfectly natural position, or at all events it is not sunken sufficiently to attract our attention. It is remarkably transparent, however, and looks like very tightly-stretched parchment. Through its posterior superior quadrant, we can see distinctly the whitish mass of the end of the long process of the anvil. Below, a shadowy area, corresponding to the niche of the fenestra rotunda, attracts our attention. Anterior to these regions lies the apparently white and perfectly smooth promontory, or inner bony wall, of the tympanum. This whitish appearance is due to the fact that the mucous membrane, which should naturally conceal the whiteness of the underlying bone, has been reduced to such a state of thinness and non-vascularity that, to all intents and purposes, the bone lies exposed to view. The same wasting away of the mucous membrane takes place on the inner side of the drum-membrane, and thus renders it unusually transparent. The radial fibres do not participate to any marked degree in this atrophy, and consequently the drum-membrane retains its firm, unyielding character.

In the first form, our treatment should be directed to the naso-pharyngeal catarrh, upon which the atrophy of the drum-membrane depends. Until recently, I had always believed that a drum-membrane, which had once been allowed to undergo atrophy of its *substantia propria* through prolonged, undue atmospheric pressure upon its outer surface, would never afterward recover any material part of its inextensibility. I am quite sure now that under proper treatment, the effect of which shall be to remove undue atmospheric pressure upon the outer side of the membrane, it will slowly regain at least some of this valuable acoustic property. As far as the second form of atrophy is concerned, I know of no treatment that is likely to prove of any service whatever.

RUPTURE OF THE DRUM-MEMBRANE, from a blow upon the side of the head, or from a violent concussion of the air in the immediate neighborhood of the ear, as when a gun or a cannon is fired, is a comparatively rare occurrence. No special treatment is required. The rupture usually heals promptly. If an acute inflammation follow the accident, it must be treated in precisely the same manner as if it had developed through the effects of a cold.

OTALGIA, that is, a pain in the ear not attributable to any discoverable lesion in either the middle or the external ear, is not an affection of common occurrence. I have seen only a few such cases, and in the majority of them I have found that the real cause of the pain was a decayed or ulcerated tooth. In these cases, the pain in the ear must be looked upon as a reflex nervous phenomenon. In a few instances I have known the pain to yield to quinine taken internally, and from this circumstance I have been disposed to consider the affection, in these cases, as a malarial neuralgia. It is probable also that rheumatism is sometimes to blame for these attacks of pain in the ear.

There are many other comparatively rare conditions and diseases of the ear, but as they are of minor importance, I must utilize the small space allotted to the subject of this article, in describing the nature and treatment of the more important affections of the organ.

AFFECTIONS OF THE AUDITORY NERVE.

The knowledge which we possess with regard to affections of the auditory nerve, is very scanty. This is due to various circumstances. In the first place, the auditory nerve, at all points throughout its course, is concealed from view. While the retina, or terminal apparatus of the optic nerve, lies comparatively near the surface of the body, and may be examined thoroughly by direct inspection upon the living subject, the *lamina basilaris*, with its delicate superincumbent structures, is solidly encased in bone, far beyond the reach of sight, and difficult to expose to view even in the cadaver. In the next place, we very rarely have the good fortune to examine, after death, the condition of an auditory nerve that has been believed to be diseased a short time previously. A few facts, however, have been ascertained in this manner, and others still have been learned by post-mortem examinations of the ear in individuals with regard to whose aural history during life nothing whatever has been known. Thus, for example, evidences of disease, in the shape of minute extravasations of blood, have been found in the brain, in the neighborhood of the rhomboid fossa, from which region the auditory nerve originates. New growths (syphilitic gummata, sarcomata, and carcinomata) involving the trunk of the auditory nerve, have been found at the base of the brain. Evidences of atrophy of the nerve-trunk have been observed. Extravasations of blood have been found in different parts of the labyrinth —in the vestibule, in the semicircular canals, and in the cochlea. The ring-shaped elastic membrane, which surrounds the foot-plate of the stirrup, has been found converted into an immovable, calcareous or osseous plate. Essentially the same changes have been observed in the secondary tympanic membrane which spans the inner end of the niche called the round window. These and other conditions have been observed after death, but unfortunately we can connect only a few of them with particular trains of symptoms observed during life. We are therefore obliged to infer what the condition of the auditory nerve is, in any given case, from the state in which we find the middle ear to be, from the manner in which the nerve performs its functions and in which the other organs lying near the auditory nerve perform theirs, from the presence or absence of certain constitutional symptoms, and finally from our knowledge of the lesions which may be found in the auditory nerve proper, in its terminal apparatus, or in some part of the labyrinthine system of chambers. Such a diagnosis partakes necessarily of a speculative character, but in the present state of our knowledge we are prevented from reaching anything of a more definite character.

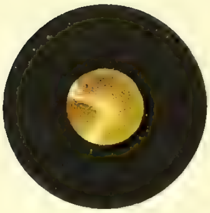
From time to time, we encounter cases in which the prominent symptom is a sudden or comparatively rapid loss of hearing in one or both ears. Inasmuch as a careful examination of all the accessible parts of the ear fails to reveal any lesions adequate to explain the deafness, and inasmuch as all sounds, whether transmitted through the bones of the skull or through the air, seem to be perceived only by the sound ear (in those cases in which the deafness is one-sided), we are accustomed to make the diagnosis of disease of the auditory nerve. In many of these cases we feel as if we might safely go a step farther, and locate the disease in that part of the auditory nerve which lies within the system of chambers called "the labyrinth." The temptation to do this is, I confess, very strong; but at the same time we must remember that our actual knowledge, whether pathological or physiological, does not justify us in making any such diagnosis.

The terms *Ménière's disease* and *apoplectiform deafness* are applied to a group of symptoms of which the most prominent are a sudden loss of hearing (on one or on both sides, and usually complete), well-marked vertigo, inability to maintain one's balance, nausea, and tinnitus. In a case of this kind, Ménière found the different chambers of the labyrinth, at the post-mortem examination, filled with clotted blood. From that time to the present, it has been the custom to associate these lesions with the train of symptoms enumerated above; but whether correctly or not, I am not prepared to say. In a very small number of these cases, the hearing returns after the lapse of a few days, either to a large extent, or, more commonly, only to a slight degree. Leeching, counter-irritation behind the ear, and rest in bed, may accomplish some good, but as a rule no treatment is found to be of any use in restoring the lost hearing.

A second and very striking type of disease of the auditory nerve is that observed in the course of *constitutional syphilis*. The loss of hearing takes place gradually, though generally in from one to four weeks the deafness becomes almost or quite complete. The symptoms of dizziness, difficulty in maintaining one's balance, and nausea, are often absent, and when they are present, they are usually much less marked than they are in Ménière's disease. The prognosis is not favorable. Dr. Roosa, of New York, once succeeded, in a case of total deafness dependent upon syphilis, in restoring a large fraction of the hearing. I have repeated the same treatment—administration of iodide of potassium in increasing doses—in two or three cases, but it has not been my good fortune to restore more than a small part of the lost function. In one of these cases, I pushed the treatment with the iodide of potassium up to the point at which my patient took three hundred grains of the remedy, every day, for a period of several days.

There are various general diseases in the course of which the auditory nerve is believed to be seriously affected. All the infective fevers seem to predispose the patient to a sudden or rapid loss of hearing, without any demonstrable simultaneous affection of the middle ear. Epidemic cerebrospinal meningitis is particularly liable to induce a sudden loss of hearing, commonly in both ears. In these cases, it is a well-established fact that the inflammation at the base of the brain spreads to the labyrinth, and probably does the chief damage in the cochlea. The pathology of the loss of hearing which is occasionally observed in mumps, is much more obscure. The same is true of the sudden deafness which occurs after a confinement. In the great majority of all these cases treatment is of no avail, and the loss of hearing is permanent.

PLATE XXIX.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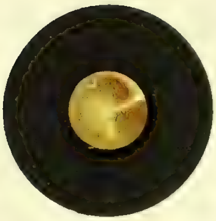
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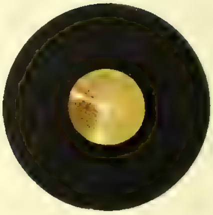
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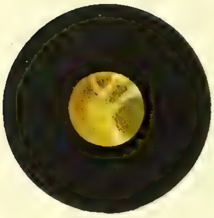
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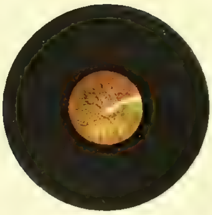
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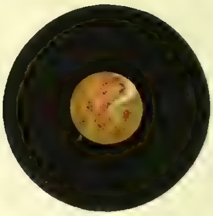
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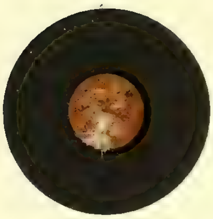
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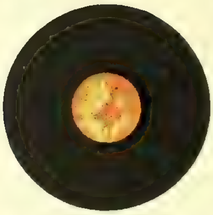
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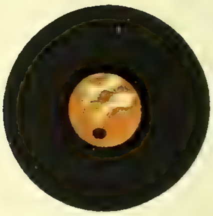
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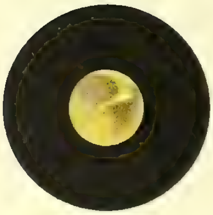
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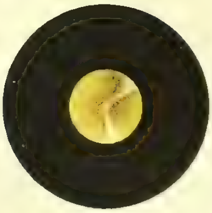
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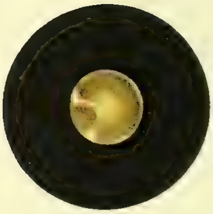
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Copied from plates drawn by Prof. Adam Politzer, of Vienn
and published in his "Beleuchtungsbilder des Trommelfells."

H. BENCKE, LITH. N.Y.

EXPLANATION OF PLATES REPRESENTING APPEARANCES OF MEMBRANA TYMPANI IN HEALTH AND DISEASE.[1]

PLATE XXIX.

Fig. 1 represents a view of the normal membrana tympani (left ear), as seen by the light reflected from an unclouded sky in broad daylight. The lighter shade of color observed in the centre of the membrane, around the tip of the handle of the hammer, is due to the reflection of light from that portion of the inner wall of the tympanum which is called the promontory. This area of lighter coloring will vary in extent and intensity according to the distance of the membrane from the promontory, and also according to the degree of transparency of the membrane itself. The color of the remaining portions of the membrane may be described as a neutral gray. The handle of the hammer begins on the left-hand side of the figure, above the middle line, as a whitish-yellow knob, the "short process," and terminates at or near the centre (or "umbo") of the membrane. The so-called "bright spot" extends from this central point almost to the periphery of the membrane, a little in front (that is, to the left) of the median line of the figure. In shape it is a well-defined triangle, whose base corresponds with the periphery of the membrane. It is produced by the reflection of light from a polished surface, and whatever other significance it may have, it certainly furnishes a valuable criterion by which we may judge of the state of nutrition of the membrane.

Fig. 2 represents a normal membrana tympani belonging to the right ear. The more solid tissues which fill the gap between the neck of the hammer and the spina tympanica posterior, and which are commonly known as the "posterior fold," are represented here. They begin at the "short process," and run backward (that is, to the left) in the shape of a sickle, along the upper boundary of the membrane. The halo-like reflection from the promontory is less marked than in Fig. 1, and the bright spot does not extend quite to the periphery of the membrane.

In the case from which Fig. 3 was taken, an oil lamp was used for illuminating purposes. Hence the reddish-yellow hue of the membrane. The delicate red line which forms the posterior limit of the handle of the hammer, represents a congested condition of what are technically known as the "manubrial vessels." These vessels, which are considerably larger than any of those which traverse the membrane proper, are the first to respond to any irritation of the adjacent auditory canal, or to show the effect of pressure (such as a speculum is apt to produce) upon the efferent veins of this part of the ear. It will also be noticed that the "bright spot" is interrupted midway between the "umbo" and the periphery of the membrane.

The membrane pictured in Fig. 4 is classed by Prof. Politzer with the three which precede it, as a normal, but unusually transparent, membrana tympani. The triangular figure seen to the left of the handle of the hammer is made up in part of the lower portion of the long process of the anvil (the whitish line which runs in a direction parallel with that of the handle of the hammer), and in part of the posterior arm or limb of the stirrup (the more delicate whitish line which runs in a direction continuous with that of the "bright spot"). The anterior limb of the stirrup is concealed behind the long process of the anvil.

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[1] These illustrations are copied, by permission, from the admirable colored plates drawn by Prof. Adam Politzer, of Vienna, and published in his well-known work "Die Beleuchtungsbilder des Trommelfells im gesunden und kranken Zustande" (Wien, 1865).

It is quite possible that at the present time—these colored drawings were made twenty years ago—Prof. Politzer might feel disposed to interpret the appearances presented in this figure as indicating a condition of atrophy (from sclerosis), rather than one of normal, though unusual, transparency of the membrane. The absence of an unusual whiteness of the inner wall of the tympanum is the only feature which seems to me to be lacking, if my supposition is correct.

Fig. 5 represents a markedly congested, but otherwise only slightly altered, membrana tympani, such as is commonly seen in the early stage of an acute catarrhal (non-purulent) inflammation of the middle ear. The chief redness is noticed along the handle of the hammer (manubrial vessels), and near the circumference of the membrane (peripheral vessels). In the intermediate space between the manubrial and the peripheral vessels, may be seen a few superficial ones, which serve as connecting links between the two systems.

In Fig. 6, the inflammatory changes are represented as having gone a step further. The epidermoid surface is less polished (commencing serous infiltration), and ecchymoses may be seen at several points, especially between the handle of the hammer and the posterior periphery of the membrane.

Figs. 7 and 8 show an advanced stage of inflammation of the membrana tympani. The parts are so much swollen and gorged with blood that the handle of the hammer can no longer be distinguished. Masses of desquamating epithelium, infiltrated with pus, appear like irregularly shaped patches of a reddish or yellowish-white color upon a purplish or bright red background. In Fig. 7, a process of granulation has raised the tissues of the membrane into low prominences. In Fig. 9, the circular dark spot in the lower part of the inflamed membrane represents a sharply cut perforation.

In Fig. 10, the following peculiarities should be noted: the marked foreshortening of the handle of the hammer, its tip at the umbo being somewhat indistinct, while the short process, which lies nearer to the observer's eye, is unusually prominent and well defined; and the decided prominence of the posterior fold.

The grayish-white margin at the periphery of the membrane represented in Fig. 12, corresponds to the annulus cartilagineus, or that portion of the membrana tympani which fits into the sulcus tympanicus. The grayish-white color is probably due to the presence of fat cells. Politzer compares it to the arcus senilis of the cornea. The free portion of the membrane in this figure seems to be unnaturally curved inward.

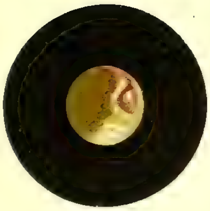
PLATE XXX.

The different figures in this plate represent the lesions which often remain after the subsidence of a purulent, destructive inflammation of the tympanum.

In Fig. 2, the appearances are as if the greater part of the right membrana tympani had been destroyed. The white circular spot above and to the right, represents the short process of the hammer, whose very much foreshortened handle runs (in the drawing) downward and backward until it seems to touch the exposed inner wall of the tympanum. A thickened remnant of the original membrane is still attached to the handle of the hammer. It somewhat resembles in shape a new moon. The rounded surface over which two or three bloodvessels may be seen to ramify, represents either the mucous membrane of the inner wall of the tympanum, or a thin reproduction of that part of the drum membrane which ulceration has destroyed. In the latter case, as the newly-formed membrane would be closely applied to the inner wall of the tympanum, mere ocular inspection would scarcely suffice to determine accurately the true relations of the parts.

Fig. 3 represents an ear (left side) from which the greater part of the membrana tympani has been removed by disease. Anteriorly (that is, toward the left) a whitish,

PLATE XXX.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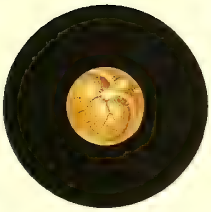
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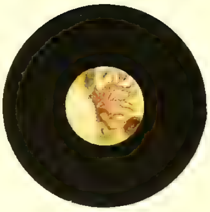
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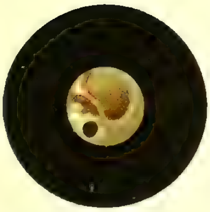
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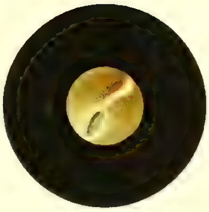
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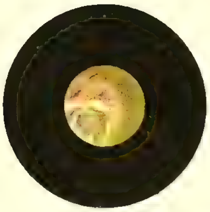
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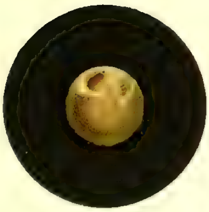
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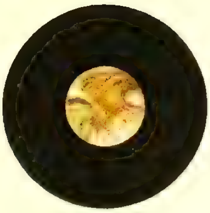
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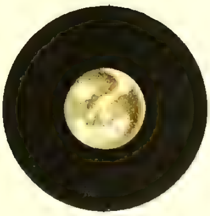
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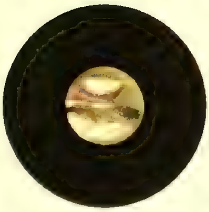
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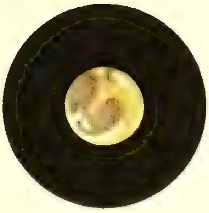
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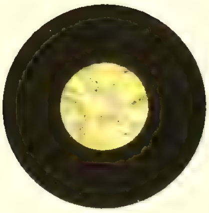
12.

pied from plates drawn by Prof. Adam Politzer, of Vienna,
and published in his "Beleuchtungsbilder des Trommelfells."

H. BENCKE, LITH. N. Y.

thickened remnant, representing about a third of the entire membrane, still remains *in situ.* The hammer has probably been destroyed, but the familiar, triangular figure, which represents the long process of the anvil and the posterior limb of the stirrup, may still be seen in the upper part of the drawing. Enlarged bloodvessels traverse the promontory. Below and to the right, will be observed a sharply outlined excavation, which represents the niche for the round window (fenestra rotunda).

In Figs. 5 and 6, the evidences of former perforations are easily recognized, the newly-formed membranes, or "cicatrices," as they are technically called, being thinner and more transparent than the surrounding, original membrana tympani. In Fig. 4, the lower perforation still remains open, and its thickened edges seem to have undergone calcareous degeneration. Two other small patches of calcareous material lie between it and the short process of the hammer. The upper and much larger perforation appears to have healed by cicatricial new-formation of membrane.

Fig. 7 represents one of two conditions, viz., either a highly atrophied and sunken membrana tympani, or one which has been entirely reproduced after total destruction. The picture presented would be the same for either condition. The handle of the hammer apparently presses with its tip against the tissues of the promontory or inner wall of the tympanum. The deep shadow between the handle of the hammer and the posterior fold, shows how atmospheric pressure or adhesions have forced this part of the membrane far inward beyond the plane which it naturally occupies.

Extensive calcareous deposits are shown in Figs. 9, 10, and 11. Extensive thickening, with still lingering inflammatory action, may be seen in Fig. 8. In Fig. 12, healing seems to have taken place despite extensive proliferative and destructive processes. In the midst of the ruins, the handle of the hammer is barely recognizable.

DISEASES AND INJURIES OF THE NOSE AND ITS ACCESSORY SINUSES.

BY

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INTRODUCTION: DESCRIPTION OF INSTRUMENTS, ETC.

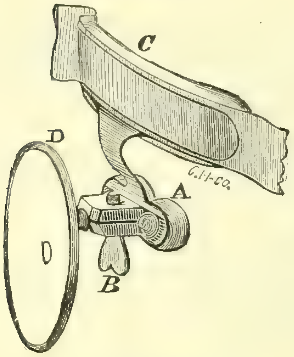
THE direct, visual examination of the nasal passages and upper pharyngeal space, first undertaken and rendered possible, by means of his "light-conductor," by Bozzini, was an obsolete art until amplified and rendered readily practicable by the genius of Czermak, and still further elaborated and better utilized, both from a pathological and therapeutical standpoint, by Fraenkel and Michel, and especially by Voltolini and Zaufal. The method introduced by Czermak is that generally employed to-day, the innumerable modifications which represent the inventive ingenuity of many specialists yielding upon practical trial to the more simple, yet fully as efficient, method and apparatus of the first-named operator. Complete *rhinoscopy* consists in both the direct inspection of the nasal passages anteriorly, through the nostrils held dilated by means of a suitable speculum, and the examination of the posterior portions of the same passages, the supra-palatine walls and their contents, the posterior surface of the velum, and the upper pharyngeal space, with the necessary aid of a small mirror which is introduced through the mouth, and which is held in a position midway between the relaxed soft palate and the posterior pharyngeal wall. The former method may properly be designated *anterior rhinoscopy* and the latter *posterior rhinoscopy*, or, more exactly, *pharyngo-rhinoscopy*.

INSTRUMENTS FOR EXAMINATION OF THE NASAL CAVITIES.—These are but few and simple: (1) A forehead reflector and (2) an argand gas-burner, or some equally efficient source of illumination; and in addition, for anterior rhinoscopy, (3) a nasal speculum; and for the posterior examination, (4) a small mirror and (5) a tongue spatula.

The *forehead reflector* is a round, slightly concave mirror, either three and a half or four inches in diameter, with a perforation in its centre, or with the glass simply left unsilvered at that point. Its focal distance should be about fifteen inches. It is attached either to an elastic headband, with ball-and-socket support (Kramer), or to a spectacle frame (Mackenzie), and may be worn over either eye, or upon the forehead; the former method is the more correct one, and the right eye is to be preferred.

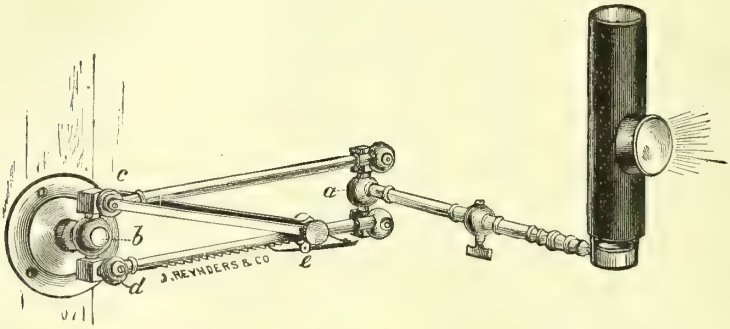
Illumination.—The form of "light" apparatus that shall be employed depends upon the choice of the surgeon; this may have a wide range, for the varieties are legion; but the basis of each is the same, and they vary only in their nature, their details, and the number of condensing lenses that are used to intensify their illuminating power. For ordinary purposes, there is no better nor more convenient light that that which is furnished by the argand gas-burner, mounted upon a drop-light or stand, which permits of the flame being lowered or elevated at will, or upon the arm of a gas bracket fastened to the wall. Such a light certainly is easily procurable, and at a slight cost if gas is obtainable; if not, as in the country, the ordinary lamp known as the "student," which burns petroleum or oil, forms a very efficient substitute. It is no difficult matter to attach to either of these lights a single plano-convex lens, two and one-half inches in diameter, which fits into the metallic tube or chimney known as Mackenzie's, if it be deemed desirable to intensify their illuminating powers, as will probably be the case when it is remembered that the light for rhinoscopy should necessarily be more intense than that used for laryngoscopy, and that sunlight is here unavailable.

Fig. 905.



Forehead reflector.

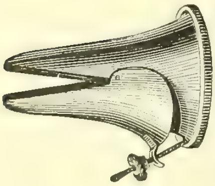
Fig. 906.



Illuminating apparatus for rhinoscopy.

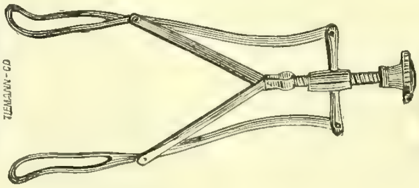
Nasal specula exist in great variety. The forms here figured will be found to be the most efficient, as well as the most recent. Fraenkel's possesses the advantage of allowing the dilatation of both nostrils simultaneously. An ordinary ear speculum answers a good purpose in children. Zaufal has

Fig. 907.



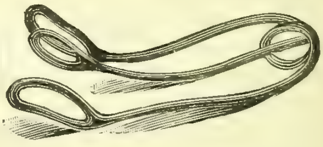
Robert and Collin's nasal speculum.

Fig. 908.



Fraenkel's nasal speculum.

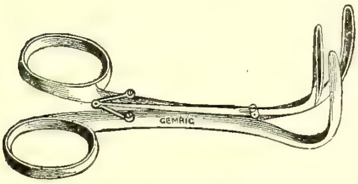
Fig. 909.



Nasal speculum.

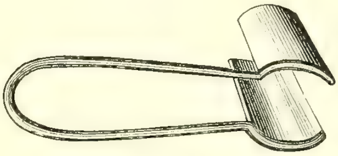
devised a long tube of metal or hard-rubber, ending in an expansion similar to that of the ear speculum (3–7 mm. in diameter, and 10–12 cm. in length), by means of which, when it has been introduced into and through the nasal passage, the pharyngeal orifice of the Eustachian tube and the posterior wall of the pharynx become visible. Voltolini, Tröltsch, Roth, and others, use a double-bladed metal speculum, in which, after introduction, the blades are separated by a screw arrangement at the handle. Schnitzler has modified this instrument by making longitudinal openings along the blades, to permit a lateral inspection. Elsberg uses a trivalve speculum similar to the tracheal dilator of Laborde; Thudichum, one in which two narrow metallic blades are separated by the resiliency of a bowed spring of wire, which holds them attached to each other. It is well adapted to facilitate operations upon the nasal passages. Finally, a hook, a bent hair-pin, a probe, or some equally simple instrument often suffices, by pulling the wing of the nostril aside, to allow of a good view being obtained of the deeper parts of the passage.

Fig. 910.



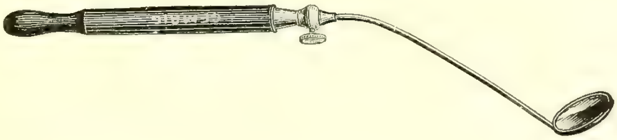
Elsberg's nasal speculum.

Fig. 911.



Thudichum's nasal speculum.

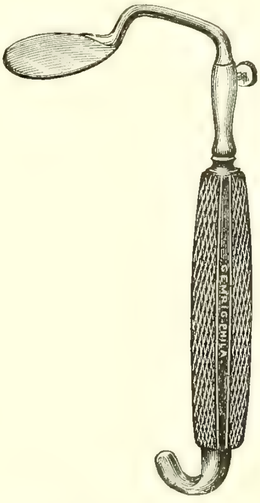
Fig. 912.



Rhinoscopic mirror.

Rhinoscopic Mirror.—Specially constructed mirrors are not necessary for rhinoscopic purposes, though many have been devised. Those of Fraenkel, Voltolini, Mackenzie, and Störk, are perhaps the best known, but the combination of tongue spatula and mirror that exists in some of these, is inconvenient and often impracticable, and the same may be said of the apparatus of Duplay, which aims to combine a retractor for the soft-palate with the mirror. The ordinary rhinoscopic mirror resembles precisely that used for laryngoscopic examination, except that it is usually smaller, and that the glass stands at nearly a right angle to the shaft, or that this is bent somewhat in the form of an italic *S* (Lennox Browne). The glass is circular, is covered with amalgam posteriorly, has a plane reflecting surface, and is set in German silver. Its

Fig. 913.



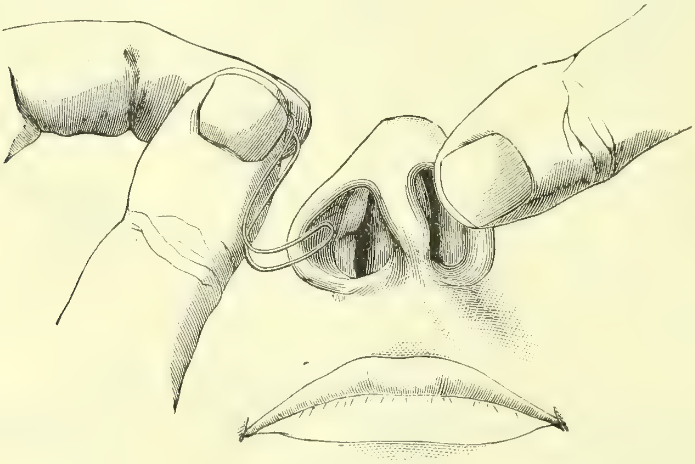
Türck's tongue spatula.

diameter is half an inch, and its thickness one-twentieth; to it is soldered, at the nearly right angle described, a partly flexible, and preferably a straight shank of metal, which terminates in a convenient handle, where it can be lengthened or shortened at will by means of a screw. The size of the mirror that should be used in a given case, depends entirely upon the amount of space existing between the patient's relaxed velum and the posterior pharyngeal wall. This will be found to vary greatly, but, as a rule, the small mirror described is the most practical.

Tongue Spatula.—The tongue spatula modelled after the pattern of Türck is well adapted to fulfil its purpose.[1]

Anterior Rhinoscopy.—The position of the patient, of the surgeon, and of the source of illumination, do not vary from those necessary for laryngoscopy; that is, the patient is seated erect, in a straight backed chair, with his head thrown slightly backward; the surgeon, seated in front of him, so adapts the position of his head, upon which he has fastened the concave forehead reflector, as to place it on a level with that of the patient, and then looks directly forwards through the perforation in the mirror, with his right eye, towards the latter's nose; the rays of light, as they come from the lamp which is placed upon the right of the patient, at the level of his ear, are then caught upon the forehead reflector, focused, and thence reflected forwards into the nasal speculum, which is now introduced into the nostril of the patient, care being taken not to pass it too high up into the narrow space between the cartilaginous septum and the outer bony wall of the nostril, where it would cause pain. Its blades are next dilated or separated, and the focus of light is carefully thrown between them and into the nasal passages; the parts of the latter now come into view, and will be seen to vary in their normal configuration, and likewise according to the nature and degree of their diseased condition. Ordinarily the anterior, and parts of the inferior, surfaces of the two lower turbinated bones, the side of the septum, and the

Fig. 914.



Anterior rhinoscopy.

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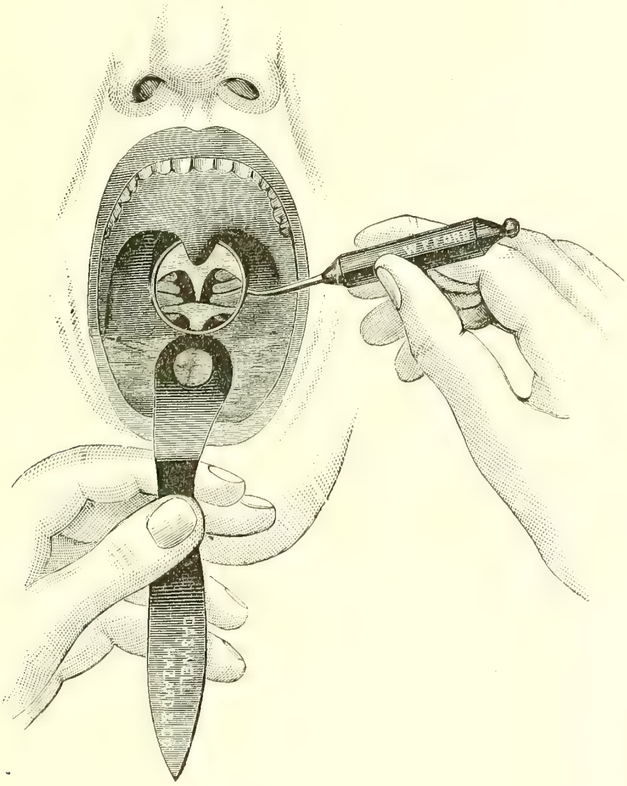
[1] See also Baginsky (Rhinoscopic methods of examination and operation), Volkmann, Klin. Vörtrage, No. 160, 1879; Harrison Allen, Aids to Diagnosis in Nasal Diseases, Phila. Med. Times, 1880–1, vol. xi. p. 613; Voltolini, Rhinoskopie und Pharyngoskopie. Breslau, 1879; and Schnitzler, Laryngoskopie und Rhinoskopie. Wien, 1879.

inferior meatus are distinctly visible, the extent of the view of the two latter depending, however, upon the natural formation of the parts; for it is exceedingly common to find a deflection of the septum nasi to one side, usually the left, narrowing more or less the respective naris, occasionally occluding it, and preventing all view of the deeper parts. On the other hand, cases are met with in which a very wide and roomy meatus permits of a view directly through it into the pharynx, and of the pharyngeal orifice of the Eustachian tube.

Posterior Rhinoscopy.—For the purposes of the posterior examination—to illuminate and convey to the eye the picture of the upper pharyngeal space, the posterior nares, and more or less of the posterior portions of the nasal passages themselves—the position of the patient and surgeon, and the direction and method of employing the light, are the same as for anterior rhinoscopy, with two exceptions: first, that the focal point of light is to be thrown into the open mouth, and on the base of the uvula; and second, that the patient, with widely opened mouth, allows the tongue to lie quietly behind the lower incisor teeth, and depresses it well down upon the floor of the mouth with the spatula or depressor. The rhinoscopic mirror having been warmed, is now carefully introduced from the corner of the mouth, with its reflecting surface upwards, carried over the tongue to one side or other of the uvula, until it passes beneath the motionless velum, and

Fig. 915.



Posterior rhinoscopy.

stands midway between it and the posterior pharyngeal wall, touching neither, and at an angle of about 130°. In this position, it will be impossible to obtain the whole picture of the parts at once, except in exceptional instances; and the face of the mirror must therefore be turned from side to side, to view the lateral pharyngeal walls; upwards, to view the vault of the pharynx; and at more or less different angles and inclinations, to see completely the parts embraced within the posterior openings of the nares.

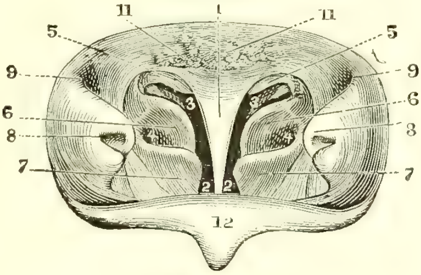
Such is the method; and a complete examination is almost always practicable, though comparatively seldom with the facility which attends the use of the laryngoscopic mirror. Three difficulties may present themselves to prevent the examination. One is insuperable—a long hard palate which approaches so nearly to the posterior pharyngeal wall, that there is no practicable degree of space left through which an examination can be effected. A second is common, and may require an additional instrumental procedure; this condition is that in which a long, broad soft palate, a long uvula, and a short distance between them and the posterior pharyngeal wall, coexist, and in which an examination can only be made when the former are drawn away from the latter. This can be accomplished by means of the so-called palate hook, made of metal, or, still better, a broad, well-curved hook of hard rubber, or a bougie with a wire centre to give the necessary firmness. The latter are much better tolerated than the former; they are introduced by the left hand gently under the palate (the right hand holding the mirror), and the palate is then drawn with moderate force towards the operator—that is, away from the posterior pharyngeal wall. This procedure rarely succeeds, however, at the first trial, though successive and persevering attempts will generally end in tiring the palatine muscles or in training them to a point of toleration, and will thus overcome the spasmodic contraction which at first follows any attempt to draw the velum forwards. As a rule, however, it will be found, that the same time that is devoted to training the patient to tolerate this hook, or any of the other forms of instrument that have been devised (Türck, Lörry, Störk), will be all-sufficient to train him to breathe quietly through the nose, and to cause the palate to hang immovable in the mouth. The third and last difficulty exists at first in the majority of cases. It is caused by the drawing up of the velum and uvula tightly against the pharyngeal wall, as soon as the patient opens his mouth and places the spatula upon the tongue, or when instruments are about to be introduced by the examiner. Quiet respiration, carried on through the nose, will overcome this difficulty, however, at once, when the velum will be found to hang motionless and free from the pharyngeal wall. If the patient cannot succeed in maintaining respiration through the nose, the palate may be made to fall forwards by causing him to emit certain nasal sounds, such as the French *en*. The first plan is however the best; the examination is then to be made with celerity, accuracy, and completeness.

Reflex irritability of the pharyngeal parts, it may here be remarked, is a far greater disadvantage than when it occurs as an impediment to laryngoscopy. A skilful and certain hand, with some training of the parts, will do much to facilitate the examination.

I believe that it will rarely be found necessary for the purposes of examination alone, though it may be for operative procedures, to acquire absolute control of the soft palate, or a wider patency of the palato-pharyngeal space, by *tying the palate forwards*, as advised by Störk and more recently by Wales. This procedure consists in passing a cord through each nostril to the pharynx, drawing the ends out through the mouth, passing them over the ear on each side, and tying them behind the head, the soft palate yielding under gentle traction, and being folded, as it were, upon itself. Bosworth suggests that a linen cord, stiffened with mucilage, or a piece of catgut, might be passed in the same way, but more conveniently, by means of a small catheter shaped like that used for the Eustachian tube. The ends of the cords are tied by a surgeon's knot of three turns, over the upper lip, or are held by an ingenious little clamp devised by Jarvis. The operation should be performed quickly and skilfully, when it is fairly well tolerated by the patient.

The Rhinoscopic Image.—As the mirror is passed into position behind the velum, the first object which attracts attention is the posterior surface of the uvula, and the next the posterior surface of the velum, a broad, reddish expanse, which arches upwards so as to cut off from view, in the majority of instances, more or less of the inferior portions of the nares proper, and thus partly hides the posterior extremities of the inferior turbinated bones. The septum nasi now comes into view, and as it is the most easily recognizable of all the parts, it serves as a landmark or guide for the rhinoscopic picture, as the vocal cords do for that of the larynx. It is a thin, sharp ridge, whitish in color, and its sides are readily seen for some distance; above, it widens, becomes of a deeper color, and merges into the parts which go to make up the vault of the pharynx. To either side of it are seen dark, ovoid openings, the posterior nares, which are more or less occupied by the three turbinated bones, bulbous bodies of a gray or ashy-red color. The middle one, with part of the middle meatus of the nose, is the most distinct. Parts only of the superior and inferior bones are visible; the former appears simply as a narrow projection from the outer wall of the nasal fossa, extending downwards, inwards, and backwards, to lose itself behind the middle turbinated bone; the inferior, which overlaps the middle bone, and the upper portions of which alone are visible, appears as a rounded, hard tumor, with an irregular and grayish colored surface. Of the meatuses of the nose, the middle is the most distinct, the upper appearing only as a dark line or depression, while the inferior is only occasionally seen. About the level of the inferior turbinated bone, further towards the sides of the picture seen in the mirror, and upon a different plane, is seen on either side a rounded, smooth projection, of a bright-red color. This is continuous below with two sharp, elevated ridges of mucous membrane, the anterior of which contains the fibres of the levator palati muscle, which pass downwards and inwards to the dorsum of the velum, where they are finally lost. These are the pillars of the pharyngeal orifice of the Eustachian tube, the rounded mouth of which lies between them at the point where they leave the rounded protuberance above mentioned. If this latter be followed upwards, backwards, and outwards, it will be seen to bound and define a deep groove, which lies between it and the plane of the posterior pharyngeal wall, the fossa of Rosenmüller.[1]

Fig. 916.



The rhinoscopic image.

If the inclination of the mirror be now changed to a more obtuse angle, or if use be made of one mounted at the laryngoscopic angle, the domelike cavity of the vault of the pharynx will be brought into view. This presents an irregular outline, resembling a glandular structure upon its surface, and extends downwards towards each Eustachian orifice in a series of usually longitudinal furrows and ridges—the adenoid tissue of the vault, or pharyngeal tonsil of Luschka. As this tumefaction—marked in some cases, absent in others; frequent in children, rare in adults under normal conditions—merges gradually into the smooth surface of the posterior pharyngeal wall, it can no longer be traced; the mucous membrane of the latter, deep-red, smooth—with the exception of an occasional follicle—and shining, supplants it.

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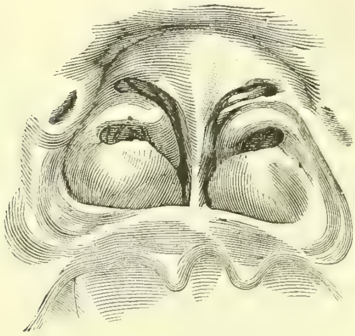
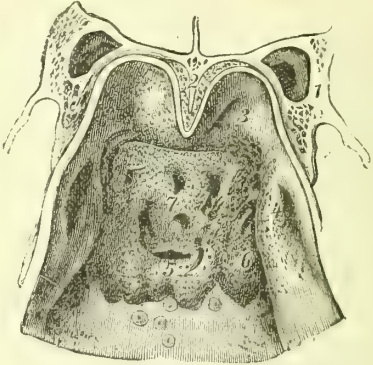
[1] It should be borne in mind that Fig. 916 is necessarily somewhat diagrammatic. Fig. 917 represents the parts of the posterior nares more as in reality they appear.

Fig. 917.



The rhinoscopic image.

Fig. 918.

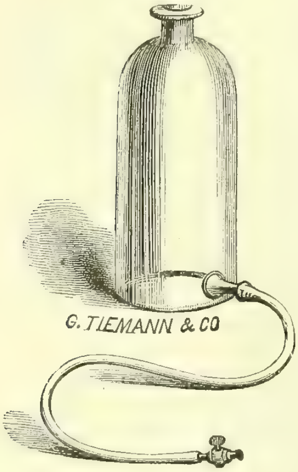


Vault of the pharynx as seen by posterior rhinoscopy.

INSTRUMENTS FOR TREATING THE AFFECTIONS OF THE NASAL CAVITIES.—The instruments employed for the preliminary cleansing of the nasal passages being, in many of their diseases, identical with those required for their subsequent medication, their general consideration at this point will be conducive to both brevity and clearness.

Instruments and Methods of Cleansing.—The best known apparatus, certainly the one most widely used to-day, is the so-called nasal douche of Weber and Thudichum, either in its original form or in one of its many modifications. Without entering into a discussion of its possible merits and positive disadvantages,[1] and while questioning, upon the basis of a practical, clinical experience, the reality of the dangers to the middle ear from its use, which have been so vividly pictured by Moos, Roosa, Knapp, and others, I must record my conviction that it is an inefficient instrument for the purpose for which it was designed, inasmuch as it does not thoroughly wash or cleanse the nasal cavities even when carefully used. This assertion is readily subtantiated by observation, and I may even add that its very general employment by the laity, unguided, too often, by professional advice, is productive of much harm; that even apparent, temporary good effects ultimately fail; and that the use of strong saline solutions in large quantity, and passed through the nares under high pressure in a divided or interrupted jet or stream, is not unfrequently an efficient factor in the propagation. if not in the causa-

Fig. 919.

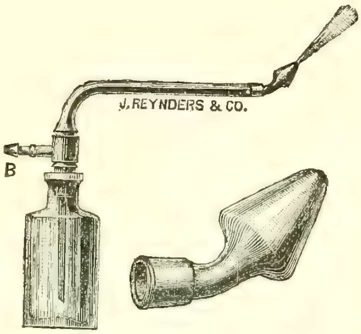


Nasal douche.

[1] Robinson, Med. Record, July 15, 1874.

tion, of a chronic inflammation of the delicate nasal mucous membrane, with its usual result of permanent infiltration of the mucous and submucous layers, rather than a means of its relief. With Robinson, I believe that the employment of these instruments should be restricted, if used at all, to exceptional cases of very aggravated catarrhal inflammation, with accumulation of pent-up and hardened secretions; and that even here the posterior nasal syringe answers a better purpose. In ordinary catarrhal disease the douche is never required. In my practice, the use of the nasal douche has been entirely superseded by that of an instrument made of hard rubber, fashioned in an effective and convenient form, and so arranged as to throw a powerful *coarse* spray. This apparatus, I, and others with me, have found, upon extended trial, to be efficient, agreeable to the patient, less painful than the douche, and devoid of all possible danger. With it, the entire nasal passages and upper pharynx may, except in exceptional instances, be thoroughly cleansed of crusts and secretions by the use of less than one ounce of the medicated fluid in spray. (The latter principle is an essential one, in the nature of the apparatus.) This instrument should be used, proper indications existing, according to the following rules, which are to be given to the patient, to insure its efficient employment on his part:—

Fig. 920.

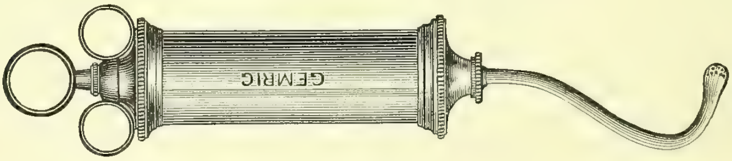


Nasal spray apparatus.

1. Warm the medicated fluid in the bottle before using, by holding the filled bottle for a few moments in hot water.
2. Hold the body erect and incline the head very slightly forward over the toilet basin.
3. Introduce the conical nozzle of the apparatus into the nostril (first on the side most occluded), far enough to close it perfectly, holding at the same time the horizontal tube of the apparatus directly outwards from the face; do not turn it from side to side, or downwards; make a trial of the spray by compressing the hand ball once, to prove that the opening in the nozzle is not occluded in the nostril, and then—
4. Open the mouth widely and breathe gently, but quickly through it in a snoring manner; avoid carefully all attempts at speaking, swallowing, or coughing; at the moment that the fluid passes into the upper part of the throat from the nostril being operated upon, a desire to swallow will be experienced—resist it—and the next second the fluid will pass forwards through the opposite nostril.
5. Hold the end ball of the apparatus firmly in the right hand (the left holds the bottle) and *operate it briskly*, until the spray of medicated fluid, which should be felt at once to enter the nasal passage, has passed around it and appears at the opposite nostril; stop at this moment.
6. Remove the nozzle from the nostril, allow the surplus fluid to run out of the latter, and blow the nose gently. *Never vigorously.*
7. Repeat the operation upon the opposite nostril.

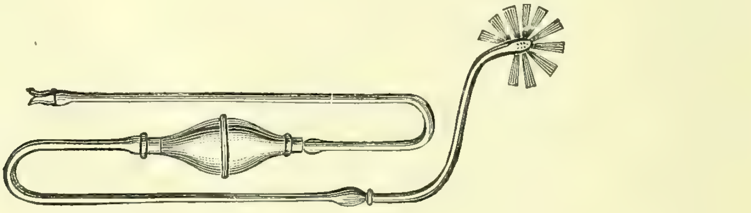
Various cleansing solutions may be used in the apparatus; one of the best is as follows: Acidi carbolici, ℈j (this quantity is often necessarily varied to suit the susceptibility of different mucous membranes); sodii biborat., sodii bicarb, āā ʒj; aquæ rosæ, glycerinæ, āā f℥j; aquæ ad Oj. Or still better, sodii bicarbonat., sodii biborat., āā ʒss; "Listerine," f℥j; aquæ ad f℥iv. Where a much larger quantity of a cleansing solution is necessarily used, as with the anterior or posterior nasal syringe, simple warm water, with the addition of borax, ten grains to each ounce—or "Listerine," in the proportion of one part to from two to ten of warm water—will answer the purpose well. Sometimes, when the disagreeable odor is strong, I use, after a thorough syringing with one of these alkaline solutions, a spray of equal parts of "Listerine" and water; it destroys fetor very quickly, and substitutes for it the pleasant odor of thyme. It will be noticed that I use no sodium chloride in any of these cleansing solutions. I believe that it does more harm than good; that the saline solution favors endosmosis as it passes over the nasal mucous membrane, and therefore increases rather than diminishes intra-nasal swelling. Many other formulæ will suggest themselves, as, for instance, Glycerini acidi carbolici, f℥jss; sodii biborat. ʒj; aquæ, ad Oj. Liquoris potassii permanganatis, f℥jss; sodii biboratis, ʒj: aquæ, Oj. Acidi salicylici, gr. x; sodii bicarbonatis, ʒj; aquæ, Oj. All solutions, whatever their nature, should be at about blood heat when used. In the severer forms of nasal disease—those attended by the formation and firm impaction in the passages of hard, dense crusts—as in simple and syphilitic ozæna, atrophic and fetid catarrh, and the like, the use of the spray apparatus will not be sufficient to dislodge these, in the first instance, and a more powerful means (short of direct instrumental removal) must be employed. This may be best obtained by the posterior nasal syringe, of hard rubber or metal, which is used to cleanse the parts posteriorly by way of the pharynx and posterior nares; or by means of a suitably curved hard-rubber tube used in the same way, its terminal extremity being pierced with coarse perforations, presenting forwards when the instrument is in place; or, perhaps, with a slit sawn transversely, so as to give a fan-like stream, and this fastened to the well-known double hand-ball rubber tube of the Davidson apparatus. For the anterior nares, the ordinary hard-rubber syringe of the aurist answers the purpose.

Fig. 921.



Posterior nasal syringe.

Fig. 922.



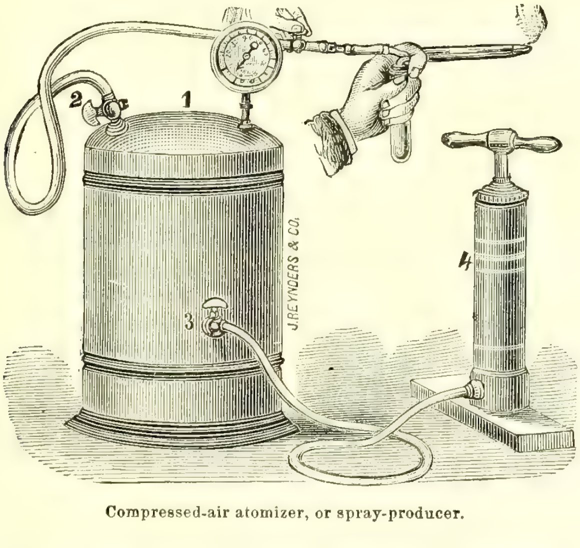
Posterior nasal tube fitted to Davidson's syringe.

Methods and Instruments of Medication.—If I exclude, for the moment, the use of caustics and of surgical measures in the management of catarrhal conditions of the nares, the treatment is based both clinically and practically either upon the employment of various medicated fluids, used in *spray* by means of some form of atomizer, or upon the use of *medicated powders*, applied with the anterior or posterior nasal powder-insufflator, in its various forms. Both methods have their warm advocates, and both are now extensively employed, and properly so, to the exclusion of the older and much less efficient methods of medication in the treatment of nasal disease. My own experience prejudices me strongly in favor of the spray. I believe that with a proper spray-tube, and with a pressure of compressed air of 40 pounds or more to the square inch, no more perfect application can be made to the parts. This should always be, if possible, through the posterior nares, the spray being driven forwards through the nose; and to insure completeness, the velum of the patient must be held forwards, by means of a suitably curved hook in the operator's left hand, in order that space may be afforded through which to throw the spray. This procedure I regard as absolutely essential, in order to secure a complete application.

Atomizers or spray producers are constructed upon two principles, both familiar to the profession, and too well known to require an extended description. A type of the first class is found in the atomizer of Richardson; and of the second, in that constructed upon the principle of Bergson; of both, modifications, mainly in form, exist, the principle remaining the same.

The most convenient and most efficient apparatus is that here figured; but its cost, though this has recently been materially lessened, may prove an obstacle to its introduction into the *armamentarium* of the general practitioner. It consists of a metal air-receiver, an air-pump, and glass atomizing tubes, curved so as to throw the spray upwards (posterior nares), downwards (larynx), and backwards (pharynx), together with the necessary connecting rubber tubes. The cylinder having been filled with compressed air up to a pressure of from 40 to 60 pounds to the square inch, as shown by the indicator, the spray-tube, with its proper end immersed in the medicated fluid contained in the small vial or test-tube, is held in the right hand, and the pressure of the air, which is now allowed to pass by turning the small cock upon the tube with the other hand, is controlled by the right thumb of the operator, pressed upon the end of the glass tube so as to compress the rubber pipe at this point. It is thus under complete control, and the spray can now be

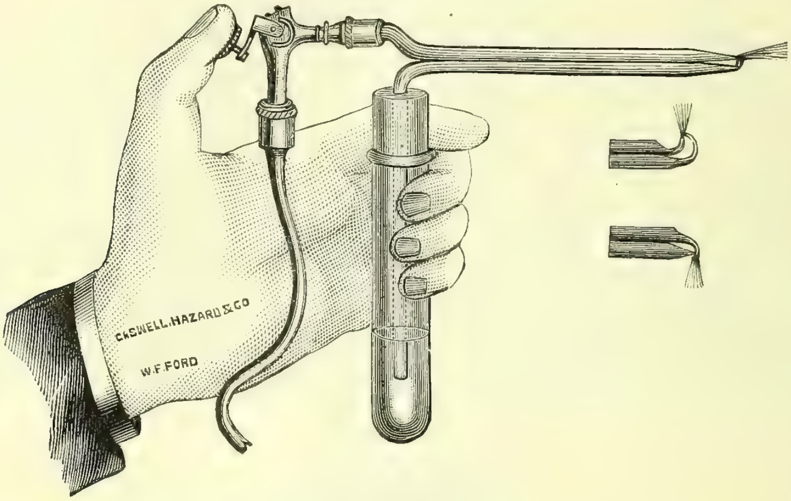
Fig. 923.



Compressed-air atomizer, or spray-producer.

caused to pass instantly in a stream, or in small jets, regulated exactly as to amount, at the will of the surgeon. The rubber tubing from the cylinder is usually made to fit to that on the glass atomizers by means of a bayonet-joint, but the more elaborate device here shown (Fig. 924) may be employed.

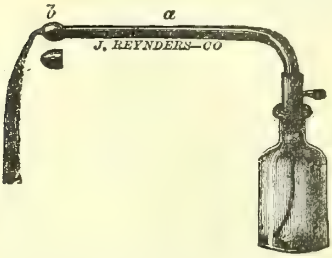
Fig. 924.



Spray-tube with patent cut-off.

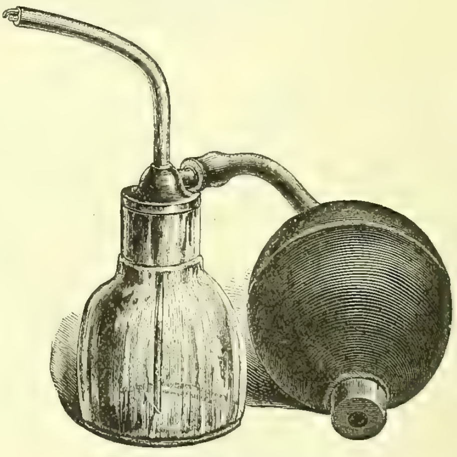
In default of this apparatus, the ordinary hard-rubber atomizers, constructed upon the principle of either Richardson or Bergson, may be used with good effect. In both, the propelling power is developed by the use of the hand air-bulbs. These should always be double; a single air-bulb gives but an intermittent current of spray; the addition, between the hand-bulb and atomizer, of a second and more elastic one, which becomes distended, by exerting a continuous pressure will furnish a steady and constant stream. The hard-rubber tube of the instrument is provided with three separate tips, arranged to throw the spray in the directions necessary; and its main disadvantages are, the length of time that it takes to develop the propelling power by means of hand-ball pressure, an important point when the instrument is in position in an irritable throat, and the fact that the current of spray is not absolutely and quickly under the control of the operator. As a rule, then, the application with this instrument

Fig. 925.



Atomizer throwing spray downward.

Fig. 926.



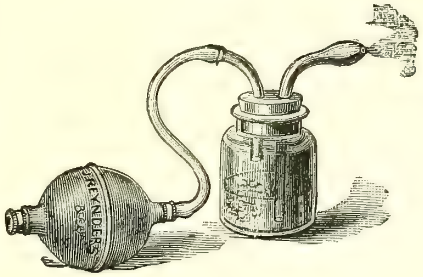
Another form of atomizer.

will have to be made through the anterior nares, the spray being driven well back into the pharynx.

Other simpler and less costly spray producers are now made in great variety, upon the plan of Bergson, and as they are furnished with metal tubes of various lengths and directions, and are easily procurable, they play a useful part in the treatment of nasal and pharyngeal diseases.

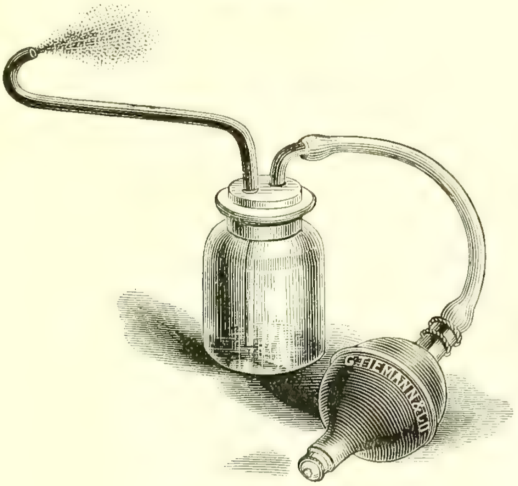
Powder Insufflators.—The most useful forms are shown in the following cuts. One is arranged (Fig. 927) to deliver a charge of the finely pulverized powder with which the bottle is charged, into the anterior nares (Smith), and the second (Fig. 928), with a longer, curved tube, performs the same operation in the posterior nares. (Robinson.) In both, the short tube is connected with a single hand-ball by means of a piece of rubber tubing, and one or two rapid and more or less forcible compressions of this hand-ball are sufficient to force a small quantity of the medicated powder into the nasal passages, either anteriorly or posteriorly, and to cover the surfaces of the parts with an even coating of it; the same result may be obtained by the use of the series of hard-rubber tubes devised by Robinson, which are so arranged that they may be attached to the tube of the cylinder of compressed air, in the same manner that the spray-tubes are connected with it; or, in default of the latter, the tubes may be arranged with a piece of soft-rubber tubing and a mouthpiece, or even with a hand-ball, so that the powder may be either blown or forced through the nasal passages by the operator himself. Although various forms of *inhaler* and *steam-atomizer* play an important part in the popular treatment of nasal catarrh, they certainly, as a rule, exercise no evident beneficial effects, and can readily do harm. In cases of acute coryza, and in those of long-standing catarrhal inflammation, with a dry and irritable

Fig. 927.



Insufflator for anterior nares.

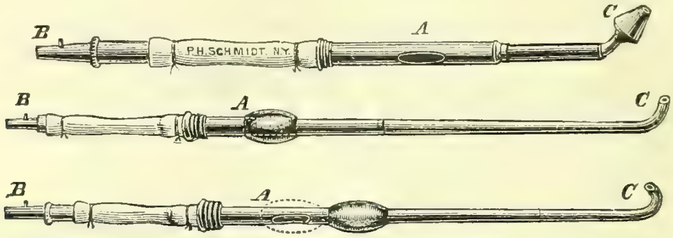
Fig. 928.



Insufflator for posterior nares.

mucous membrane, simple steam, or warm, atomized inhalations, may occasionally be indicated. Robinson recommends dry, cold inhalations of volatile matters in old catarrhal inflammations of the nasal fossæ, and says that excessive secretion is diminished by their use to a notable degree.

Fig. 929.



Robinson's tube for insufflation of nares.

Diseases of the Nasal Passages.

Acute Coryza.—Sudden exposure to a draft of cold, damp air, especially when the body is overheated, or the sudden chilling of any part of the cutaneous surface—especially of the extremities—under the same conditions, is all-efficient, even in healthy individuals, in bringing about an acute inflammation of the Schneiderian mucous membrane, which may remain in exceptional cases confined to one nasal passage, but usually affects both, and not infrequently extends thence into the neighboring cavities of the nose, and even involves the Eustachian tubes; other causes, in rarer instances, produce the same effects. Acute coryza is one of the earliest manifestations in several of the exanthematous fevers. Attacks of an obstinate character are produced by the inhalation of irritating gases and vapors, dusts, and powders; a peculiar idiosyncrasy often exists in respect to the irritation caused by certain drugs, such as ipecacuanha and iodine in some individuals. The internal use of iodide of potassium may cause an acute coryza, and the same is true of other mineral poisons. Trousseau has called attention to the relationship existing between asthma and coryza, and the latter is often the direct result of the extension of a catarrhal inflammation from contiguous mucous surfaces, such as the conjunctival, or that of the pharynx. As one of the initial manifestations of congenital syphilis, it is seen in the infant; and recently Mackenzie[1] has called attention to the influence of irritation of the sexual apparatus as an etiological factor in its production. Usually sporadic, it may become epidemic under special conditions of the atmosphere.

The question of its *contagiousness* has attracted some attention, and is still held in dispute.[2] Robinson believes that when encountered among the early conditions which point to the development of an acute, general disease of epidemic nature, it is so without doubt, just as the disease of which it forms an integral part; and that even when sporadic, and when not followed by ulterior symptoms, there is a probability of its being communicable. All practitioners will unquestionably recall instances in which the affection has developed successively, not simultaneously, in members of the same family, without other reason than the mere fact of its presence in some one person.

[1] Am. Jour. Med. Sciences, April, 1884.
[2] Blackwell, Med. Record, Jan. 10, 1880.

Fraenkel cites instances in support of the view of its direct contagious influence, while, on the other hand, various experimenters have failed in all attempts at inoculation of the healthy mucous membrane with the secretions of coryza. (Friedreich.) I believe it fair to assume, in the light of our present knowledge, and reasoning from analogy, that the secretions of an acute coryza are, at certain times and under certain conditions, contagious; and clinical experience endorses this view. These conditions depend mainly upon the peculiar susceptibility of the subject to its influence, and upon the stage of the nasal disease in which the secretions are taken, but in no event is the occurrence a common one; the affection, in the great majority of cases, runs its usual course in its subject without being communicated to others, and the question is of practical interest only in view of its possible bearing upon prophlyactic measures.

The *symptoms* of an acute coryza are well known, and vary within considerable limits, from the mere consciousness of local uneasiness to severe pain, fever, and marked constitutional disturbance. The preliminary chill, or at least chilly sensation, is usually followed by a slight rise of temperature and increase of the pulse, with muscular pain and a general feeling of malaise. The local irritation and sensation of dryness in the nose are coincident with the stage of congestion and absence of secretion which mark the beginning of any acute inflammation of a mucous membrane, and lead to constant sneezing; this lasts but an hour or two, and is followed by an acrid, watery discharge from the nasal passages, which are now occluded by the swelling and engorgement of the tissues, so that oral respiration becomes a necessity, the senses of smell and taste are both blunted, and the voice becomes nasal in character. This occlusion is variable—the inter-vascular communications between the nasal passages being free and numerous through the peculiar erectile tissue, with large vein cavities, demonstrated by Kohlrausch and Bigelow to lie between the periosteum and the mucous membrane covering the turbinated bones, especially the inferior—and gravitation of blood and serum from one nasal passage to the other is often sudden and complete. The glandular structures being abnormally stimulated, the discharge increases progressively in quantity and changes in character, being at first mucous, with epithelial elements alone; and afterwards muco-purulent, with a few red blood corpuscles; or even purulent, and loaded with young cells. Meanwhile the inflammatory process extends, involving, perhaps, the frontal sinuses, when it gives rise to severe frontal headache; or the lachrymal duct, with resultant sensitiveness of the congested conjunctivæ to both pressure and light; or the Eustachian tubes, with pain in the ears, ringing noises, and dulness of hearing. If it extend to the pharynx, the patient will complain of sore throat, a usual complication; while if it involve the larynx and trachea, symptoms referable to those regions, with increase of the febrile movement, will be present.

The irritating qualities of the saline discharge, containing ammonia in the earlier stages, inflame and excoriate the margins of the nostrils and the upper lip; while the later discharge, muco-purulent, and greenish or yellowish in color, gives rise to an unpleasant odor, and not infrequently desiccates into crusts which are removed with difficulty. Fibrin is occasionally secreted, especially in infantile coryza, and in the form met with in exanthematous fevers, and forms a membranous layer over the turbinated bones, resembling, and requiring to be distinguished from, the pseudo-membrane of diphtheria (see page 395). The attack lasts from three days to one week or more, in severe cases, and fresh attacks sometimes supervene when the first undergo resolution. Alternation from one nasal passage to the other may occur; and recurrence of the disease, with intervals of a few days, and for an indefinite period, is occasionally met with. As a rule, however, complete resolution occurs within the above-mentioned time, especially if measures have been taken to control the inflammatory process. The termination of the disease in suppuration is very rare, and fatal cases of coryza have been recorded only as occurring in aged persons or in infants, in both instances death being due either to obstructed respiration or to interference with nutrition.

Acute coryza in the infant assumes features that are not present in the same disease in the adult, and the immediate danger is correspondingly increased. This increased danger lies both in the obstruction to nasal respiration caused in the small and narrow passages by the tumefied mucous membrane, and in the difficulty with which the child is nourished, owing to its inability to hold its mouth, which is required for respiratory purposes, closed long enough to take the breast. If the attack be prolonged, not only will the infant lose strength, but the prognosis, in not a few instances, will become decidedly grave.

Syphilitic coryza in the infant is not always clearly defined as regards its true nature. An acute, persistent coryza, occurring in a very young infant, must always be regarded with suspicion; and, if a clear clinical history of the disease in the parents fail, resort to a mercurial course of treatment is certainly justifiable in attempting to establish the diagnosis.

Gonorrhœal coryza in the infant is the result of infection of the nasal passages by secretions from the vagina of the mother during delivery; and, when seen in the *adult*, arises from the direct conveyance of the poison to the nasal mucous membrane by the fingers, soiled pocket handkerchiefs, and the like. The symptoms are those of an aggravated, purulent, catarrhal inflammation or coryza.

Treatment of Acute Coryza.—The success of the abortive treatment of an acute coryza depends entirely upon the promptness with which it is instituted. Many remedies are vaunted—none, perhaps, are specific and unfailing in their action. Among the commonest is the administration of a full dose of the tincture of the chloride of iron, or quinine (gr. x–xv), followed at bedtime by hot alcoholic drinks, and a mustard foot-bath; or, if much local pain and distress exist, a Dover's powder (gr. x). Cohen advises the administration of chloroform to produce free anæsthesia, and claims that an attack may thus be aborted. Robinson recommends one of the following prescriptions:—

℞.—Spirit. ammoniæ aromat., f℥iss.

Sig.—Teaspoonful in water (f℥j–f℥iss) every two hours.

Or,

℞.—Ammonii carb., ʒj;
Liq. morph. sulphat. (U. S.), fʒj;
Mist amygdalæ, ad f℥iij. M.

Sig.—A teaspoonful in water (f℥j) every hour during six hours, and afterwards every hour and a half.

If there be much fever, tincture of aconite root (⅛ to ¼ of a drop to each dose) may be substituted for the morphine in the last mixture; and for the relief of the local inflammation and its attendant pain and discomfort, a powder of—

℞.—Pulv. fol. belladonnæ, gr. xx;
Pulv. morph. sulph., gr. ij;
Pulv. acaciæ, ad ℥ss.

may be insufflated into the nasal passages both anteriorly and posteriorly.

The inhalation of simple hot steam, or of steam medicated with compound tincture of benzoin, is also often grateful to the patient; and a powder of sugar of milk, gum, or bismuth, rubbed up with a little morphine (gr. ij–ʒj), or one of starch powder with an equal part of camphor, is of service, if used as a snuff. After the discharge, however, has once set in—in other words, after the inflammatory process has once been firmly established—such measures fail as abortive means, and the efforts of the physician must be limited to curtailing the affection by controlling, as far as is possible, its inflammatory action. To this end the above remedies may be continued, aided and combined with such diuretic, diaphoretic, and laxative mixtures as are indicated in the special case.

The local use of inhalations of iodine, much vaunted creasote, carbolic acid, ammonia, and the like, in this stage of the affection, are of little if any service, aside from giving temporary relief, and are sometimes positively harmful.

External applications of emollients, such as vaseline or suet, occasionally give relief; and the same may be said of the use of vapor or hot-air baths.

As the process reaches its later, inflammatory stages, and the muco-purulent discharge sets in, local treatment may be employed with considerable success. It should consist in the application, by means of the spray apparatus, of some watery solution of an astringent (see page 378) to all parts of the inflamed and turgid mucous membrane, and this should be continued at suitable intervals until complete resolution has been established; for there can be no question that it is to neglect of these cases of acute coryza, especially in this stage, and to indifference to the fact of their complete or incomplete resolution, that the development of chronic catarrh can be charged in a majority of instances.

Acute coryza in the infant can best be treated by thorough cleanliness, attained by the employment of a camel's-hair pencil, used with a weak solution of borax to wash out the nasal passages, and by the subsequent insufflation of powders into the nasal passages anteriorly. Robinson recommends one of equal parts of finely pulverized white sugar and camphor with powdered tannin (gr. xl–ʒj), and speaks enthusiastically of its good effects. If it be determined that the syphilitic taint exist, to this local treatment must, of necessity, be added the use of some form of mercurial, or of mercury and iodide of potassium, in doses suited to the age of the child, and continued for days or weeks, according to the judgment of the practitioner and the demands of the particular case.

Idiosyncratic coryza—or, as it has been variously termed, rose or June cold, hay fever or asthma, and autumnal catarrh—may be defined as an acute coryza, showing a peculiar periodicity, and not unfrequently attended by reflex, asthmatic symptoms. It is due, as far as our present knowledge extends, to the inhalation, by persons possessing some peculiar and individual idiosyncrasy, of the pollen of certain grasses or flowers; and while it shows no distinction in attacking both dwellers in cities and dwellers in the country, it shows a predilection for those of high estate. (See page 451.)

Its treatment will not vary, in general, from that of an ordinary acute coryza; but it is often unsatisfactory and even futile, unless a temporary change of residence be made during the usual duration of the attack. With the object of destroying the vegetable organisms upon which the disease is supposed to depend, sprays or injections of carbolic and salicylic acid are used. Helmholz advises the use of an injection of the hydrochlorate of quinia (1–100). A plan of treatment, however, which succeeds one year in aborting or relieving the attack, will often fail the next. There is no specific remedy for the disease. The asthmatic complication may often be quickly relieved by the use of the following prescription:—

℞.—Potassii iodidi, ℥j;
Liq. potassii arsenitis, fʒj;
Aquæ, f℥iv. M.
Sig.—A teaspoonful every four or six hours.

CHRONIC CORYZA.—The term chronic coryza, or chronic nasal catarrh, may very properly be used to replace a variety of terms which are to day employed in literature to signify one and the same affection. I believe that such a multiplicity of names falls far short of its object, can but serve to confuse the subject, and leads to faulty diagnosis and often to improper treatment. Bosworth, from a pathological point of view, if not correctly from an anatomical, defines the nasal cavities as extending from the nostrils to the free border of the soft palate, thus including the upper pharynx. Clinical experience teaches us that in most, if not in all cases of chronic nasal catarrh, the vault of the pharynx is involved in the morbid process; and the converse is likewise true: though the pharyngeal process be the more prominent, few cases exist in which the nasal passages also are not implicated. Chronic coryza, or chronic nasal catarrh, may therefore be defined as a chronic, catarrhal inflammation of the nasal mucous membrane and that of the vault of the pharynx, and the term should be understood to include those of post-nasal catarrh, post-pharyngeal catarrh, retro-nasal catarrh, and adenoid hypertrophy of the vault of the pharynx, which are so commonly used. Clinically, several varieties of chronic coryza are met with, each possessing individual appearances upon rhinoscopic inspection, giving rise to widely different symptoms, and requiring a distinct method of treatment. Upon the correct appreciation of the differences between these varieties, depends the success of the measures undertaken for their relief.

The varieties of the disease are classified by Bosworth[1] in a form, that, when slightly modified, commends itself for its simplicity and clearness, and can be proven to be clinically true. 1. *Simple chronic coryza*, a chronic inflammation of the nasal mucous membrane, characterized by an abundant discharge of mucus, but attended by no marked structural changes. 2. *Hypertrophic nasal catarrh*, a chronic inflammation of the mucous membrane, characterized by an excessive secretion of mucus or muco-pus, and also marked by certain structural changes in the membrane, by which this is thickened or hypertrophied. This hypertrophy involves not only the membrane lining the nasal cavity proper, but also the glands at the vault of the pharynx. 3. *Atrophic nasal catarrh*, a chronic inflammation of the nasal mucous membrane, in which the glandular structures are implicated to such an extent as to interfere seriously with their function, the membrane thus lacking its normal supply of mucus, and becoming dry, and secretions accumulating subsequently into dry, hard crusts, and decomposing, giving rise to a purulent fetid discharge and to an offensive odor (fetid catarrh).

Simple Chronic Coryza.—Seen as a rule, perhaps, as the evident and direct consequence of oft-repeated, and especially of neglected, attacks of acute inflammation, it, on the other hand, frequently manifests itself by a slow and gradual progression, without previous recognizable cause, and by no means necessarily dependent upon any constitutional taint of scrofula, although the possible influence of the latter, as well as of syphilis, herpetism, and, with adults, diathetic conditions, upon its causation, should not be overlooked.

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[1] Bosworth, Diseases of the Throat and Nose. New York, 1881.

The main symptom is the increased discharge of mucus or muco-pus, which, being semi-fluid and thin, is easily removed by blowing the nose, or by being drawn back into the pharynx and thence expectorated. There is no thickening of the mucous membrane, and consequently no obstruction to nasal respiration and no change in the voice. The disease being confined, as a rule, to the respiratory portion of the nasal passage, the sense of smell suffers no interference, and, the membrane being soft and moist, there is no tendency to the accumulation of secretions into crusts, nor to decomposition. The main importance of the affection then, its symptomatology being but slight and giving rise to no annoyance, lies in its tendency to progress into the further and more serious forms of catarrh unless it be promptly arrested by judicious treatment. Rhinoscopic examination will show a reddened and congested mucous membrane flecked with mucus, throughout the nasal passages. At the vault of the pharynx the appearances are more marked, and the glandular structures here present are swollen and covered by a thicker and more tenacious mucus.

Aside from meeting any indications for constitutional remedies that may exist in a given case, the *treatment* lies—and the statement is true for the large majority of instances—solely in the local application of medicaments, in spray or powder, to the affected nasal passages. To insure the successful use of these, thorough preliminary cleansing of the passages is requisite. This may be accomplished, perhaps, by the patient using his handkerchief, unaided by any form of artificial apparatus. Should the latter, however, be found necessary to effect the complete removal of the secretions—and I repeat that an apparatus is much oftener used than is really needed (see page 366)—the coarse spray-producer, already described, may be employed with an alkaline, cleansing solution to the best advantage (see Fig. 920); rarely, if ever, in this form of the disease, is the posterior nasal syringe required. Following the cleansing process, which must be undertaken by physician or patient with at first daily, and then gradually diminishing, frequency, the next step consists in the application of the medicament, usually a mild alterative, resolvent, or astringent solution or powder. If the spray apparatus in one of its forms—preferably the spray with compressed air as the motive power—be chosen as the means, some one of the following solutions may be used with the anterior or the posterior nasal spray-tube, or both, and should be selected with due deliberation, in view of the special indications presented by the case, care being exercised that the application is of such a strength as to cause no irritation of the nasal mucous membrane, one much more susceptible than that of either pharynx or larynx. A preliminary, careful trial with the chosen solution or powder will quickly serve to prove the membrane's peculiar susceptibility, in a given case, to both the drug and its strength, and such a trial should be made in every instance. The following are the solutions that I most commonly use, given in the order of their preference: (1) Zinci iodidi, gr. x–f℥j; (2) Zinci sulpho-carbolat., gr. ij–f℥j; (3) Zinci sulphat., gr. v–f℥j; (4) Ferri et ammonii sulphat., gr. iv–f℥j; (5) Ferri perchloridi, gr. v–f℥j; (6) Acidi tannici, gr. v–xx–f℥j; (7) Potassii chlorat., ℈j–f℥j. In any one of these formulæ, "Listerine"[1] may be substituted, in part, for the water, in the proportion of one part of the former to three of the latter. If the simple rhinitis has advanced far towards the hypertrophic stage, then I commence at once with—

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[1] This preparation contains the essential antiseptic constituent of thyme, eucalyptus, baptisia, gaultheria, and mentha arvensis, in combination; each fluidrachm also contains two grains of benzo-boracic acid. It may be used in any of these solutions, in part with water, as a menstruum, and will be found to serve a useful and pleasant purpose where an antiseptic is desirable.

℞.—Iodini cryst., gr. iv;
Potassii iodidi, gr. x;
Zinci iodidi,
Zinci sulpho-carbolat., āā ℈j;
"Listerine," ℥j;
Aquæ, ad f℥iv. M.[1]

In case the solutions, mainly of mineral astringents, that have been given, are not well borne, a powder may be substituted with excellent results, and, indeed, is particularly applicable in this form of the disease. As a rule, however, I am not a warm advocate of the use of powders in the treatment of rhinitis. In the form under consideration, where the secretions are readily removable, and the parts soft and absorptive, they will do good, but in hypertrophic rhinitis they are, I believe, of little use, and in atrophic or fetid rhinitis, they are absolutely contra-indicated. The powders may be applied by means of the anterior or posterior nasal powder-blower, after the parts have been well cleansed.[2]

Whatever be the plan of treatment instituted—and it and its details may readily be determined upon from what has been said—it is to be steadily persevered in, not necessarily in these cases under the direct manipulations of the surgeon himself, but certainly under his general supervision, and at suitable intervals, until the morbid conditions for which it was undertaken are alleviated.

Hypertrophic Nasal Catarrh.—If the simple form of chronic catarrh just described be permitted to run its course without interference, in certain cases the results of the continued chronic inflammatory process are sooner or later seen in marked proliferation of all the normal elements of the delicate mucous membrane—in other words, in a true hypertrophy of tissue. This hypertrophy, specially prone, mainly from anatomical reasons, to take place in the nasal passages, affects both the superficial and deep layers of the mucous membrane, the changes consisting in the development of new connective-tissue elements and cellular infiltration in the deeper structures; implication of the muciparous glands, which become distended, and their walls thickened, especially those located at the vault of the pharynx where the hypertrophic process expends itself more upon the glandular elements than upon the mucous membrane proper; and increased cell-growth in the epithelial elements, leading rapidly to abnormal thickening of the superficial layers; the bloodvessels of the parts, at the same time, become dilated and increased in number, their hypertrophy occurring especially over the inferior turbinated bone, in the reticulated structure, or erectile stroma, which lies between the periosteum and the superjacent mucous membrane.

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[1] In order to save repetition, the formulæ of the solutions more commonly used in the treatment of the various forms of nasal catarrh, are here given in the usual strength in which they are employed. Other combinations and other remedies will suggest themselves.

Acidi tannici, gr. v–xx–f℥j.
Aluminis, gr. v–f℥j.
Auri chloridi, gr. x–f℥j.
Cupri sulphatis, gr. v–f℥j.
Ferri et ammonii sulphat., gr. v–f℥j.
Ferri perchloridi gr. v–f℥j.
Ferri sulphatis, gr. v–f℥j.
Potassii chloratis, ℈j–f℥j.
Zinci chloridi, gr. iij–f℥j.
Zinci iodidi, gr. x–f℥j.
Zinci sulphatis, gr. v–f℥j.
Zinci sulpho-carbolatis, gr. ij–f℥j.
Argenti nitrat., gr. ij–iij–f℥j.
Ammonii chloridi, gr. v–x–f℥j.
Tinct. krameriæ, fʒj–f℥j.
Tinct. kino, fʒj–f℥j.

[2] The following formulæ for powders are taken from Robinson and others:

℞.—Acid. salicylic., gr. x;
Acid. tannic.,
Bismuth. subcarb., āā ʒj. M.

℞.—Zinci chloridi, gr. v;
Pulv. belladonnæ, gr. x;
Pulv. amyli, ℥ss. M.

℞.—Argenti nitrat., gr. ij;
Bismuth. subnit., ʒij. M.

℞.—Pulv. cubebæ, ℥ss;
Pulv. sodii bicarb., ʒij;
Pulv. acid. salicylici, gr. x;
Pulv. sacch. alb., ʒij. M.

℞.—Ferri sulphat., ℈j;
Pulv. amyli, ℥j. M.

℞.—Pulv. iodoform., ʒij;
Pulv. camphoræ, ʒj;
Pulv. acidi tannici, gr. v;
Pulv. acaciæ, ʒij. M.

℞.—Hydrarg. chlor. mitis, ʒj;
Pulv. morph. sulph., gr. j;
Pulv. bismuth. subnit., ʒij;
Pulv. sacch. alb., ʒij. M.

℞.—Ferri et ammonii sulph., ℈j;
Pulv. amyli, ℥j. M.

℞.—Aluminis, ℈j;
Pulv. amyli, ℥j. M.

℞.—Potass. chlorat., ʒss;
Pulv. amyli, ℥j. M.

This hypertrophy, involving then all the structures which overlie, especially the two inferior turbinated bones, seldom presents a perfectly smooth surface. At the posterior extremities of the inferior turbinated bones, the nodulation and irregular thickening are most marked.

The *symptoms* of this affection are dependent upon the pathological changes which have been described. The hypertrophy of the tissues, especially throughout the respiratory channel of the nose, leads to intermittent or permanent occlusion and obstruction to the passage of the air current, while the involvement of the glandulæ, especially at the vault of the pharynx, gives rise to an excessive discharge of thick, tenacious mucus, or muco-pus, of a yellowish and opaque appearance. Upon this obstruction, caused by the hypertrophied condition of the parts, depends also the interference with the senses of smell and taste, and ultimately—from this cause, and also from the extension of the inflammatory process—with the sense of hearing, through involvement of the Eustachian tubes and perhaps of the middle ear; and likewise the change in the character of the voice, which acquires a nasal intonation. The increased flow of secretion, prevented from passing normally from the anterior nares, runs into the pharynx or lodges behind the velum, and is only removed thence by means of vigorous and disagreeable efforts at hawking and clearing the throat. (It may here be observed, that this sensation or symptom, one commonly complained of by the patient, needs to be differentiated as to its cause from the precisely similar one, to which the presence of an elongated uvula will give rise.) Contrary to what is generally believed, fetid or offensive secretions are not an accompaniment of this variety of catarrh, nor is the occurrence of crusts a common occurrence. Ulceration never occurs, and epistaxis only occasionally, and then from the anterior portions of the nasal septum, and as the result of direct, mechanical interference with the parts by the patient (see page 397). Partly by the gradual extension of the inflammation, from the nares and upper pharynx to the contiguous parts, and partly through the pernicious results of enforced oral respiration (see page 402), constantly aggravated also, I do not doubt, by the violent efforts at hawking made by the patient, the inflammatory process extends to the lower pharynx, and thence invades, in course of time, both the larynx and upper trachea. Symptoms referable to the chronic inflammation of these organs—mainly sore throat, cough, and alteration in the character of the voice—must then be added in time to those of the original condition. The mucous membrane of the whole upper respiratory tract, under these circumstances, becomes irritable, and peculiarly susceptible to the influence of cold and dampness.

Upon examination of the nose *anteriorly*, with the aid of a nasal speculum and good illumination, distinctive appearances can be easily recognized. The visible mucous membrane is red, thickened, velvety in appearance, and vascular. The anterior hypertrophied extremity of the inferior turbinated bone may project so far outwards into the nasal passage as to touch the septum, opposite to it; its tissues are soft and doughy, and when indented by a probe recover themselves slowly. The hypertrophy seems to affect the tissues upon the inferior surface of the bone most decidedly, and the inferior meatus of the nose is often occluded by the mass; the middle meatus may be overhung by the thickened membrane coming from the middle turbinated bone, but to a less extent. The floor of the nostril is free, and usually the side of the septum. All parts are more or less decked, unless recently cleansed, with thick, tenacious mucus.

Posteriorly, by the aid of the rhinoscopic mirror, the posterior extremities of both middle and inferior turbinated bones, especially the latter, will be seen to present peculiar and characteristic appearances. The hypertrophy of the tissues is much more marked usually than is the case in the anterior nares, and the parts are covered by a thickened mucous membrane, of a whitish-gray color, and with an irregular, corrugated and fissured surface; the extremity of the inferior turbinated bone, indeed, resembles an irregular-shaped tumor, lying on the floor of the nostril, and its size may be so great as to nearly, perhaps completely, occlude the posterior orifice of the naris. The condition here described may exist in varying degrees in both nasal cavities, and the obstruction in the passages that it causes, is still further increased by the thickening of the tissues upon both sides of the nasal septum, especially in its upper portions.

The parts at the vault of the pharynx have been alluded to both in respect to their peculiar nature and structure, made up as they are mainly of glandular tissue, and in reference to the fact that they are always implicated, to a greater or less extent, in any case of chronic inflammation of the nasal passages, of some duration; it remains to be added that the physical results of a chronic inflammation of the "pharyngeal tonsil," as it is termed, are peculiar. The glandulæ are involved to a much greater extent than the mucous membrane, and as a result of their excessive hypertrophy, added to and increased by the hyperplasia of their connective tissue and the increase in number and size of the bloodvessels, associated with the thickening of the mucous and submucous structures, a veritable tumor or tumors are developed, which have received the specific name of *adenoid vegetations of the vault of the pharynx*, and are often treated of as a separate and distinct affection.[1] The size, configuration, and extent of these vegetations, or adenoid hypertrophies, are variable; they may exist only to such a degree as to cause a slight elevation of the tissues at the vault of the pharynx, and to obliterate its concavity; they may stud the entire pharyngeal roof, from side to side, hang over the posterior orifices of the nostrils, and completely hide the pharyngeal orifice of the Eustachian tube; the masses may be fimbriated, hang in grape-like clusters, or be cylindrical. I have seen them so large that the entire upper pharynx was occluded and occupied by the tumor, and that the lower edge of the mass was readily brought into view, through the mouth, by simply drawing the soft palate slightly forwards. Such excessive conditions, however, are unusual; generally, a rhinoscopic examination will show the rounded vault of the pharynx, and occasionally its upper lateral walls, to be occupied by a thickened and nodulated mass projecting strongly here and there from the underlying bony surface in the form of longitudinal ridges, and traversed in various directions by seams and fissures. As a rule they appear as flattish cushions, and only occasionally present themselves as small, isolated and rounded masses, or are gathered into "worm-like" clusters. The mass here described tapers off as it approaches the middle pharynx, until finally a smooth, though congested mucous membrane, dotted with small rounded eminences, marking the site of the outlying hypertrophied follicles of the pharyngeal tonsil is reached; above, it is separated from the plane of the posterior nares by a sharp, deep line of demarcation. The consistency of the tumors is soft, they do not bleed readily, and their color is of either a light pink or deep bluish-red. They are, as a rule, seen only in children and young persons. Adults, even the victims of an old-standing nasal catarrh, seldom, if ever, exhibit the appearances of excessive hypertrophy of the glandular tissues at the vault of the pharynx, here described. Its absence in them, and its frequency in children, would seem to argue in favor of an atrophy of these structures, as life advances; or, as Cohen suggests, it may be that changes occurring towards middle life, render this tissue like the analogous tissue of the tonsils and agminated glands of the intestine, insusceptible to the catarrhal inflammations of youth.

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[1] W. Meyer, Hospitals-Tidende, Nov. 4 og 11, 1868. Medico-Chirurgical Transactions. London, 1870. Löwenberg, Les Tumeurs adénoïdes du Pharynx Nasal. Paris, 1879.

Treatment.—Since hypertrophic nasal catarrh is the form of the affection which more frequently presents itself for treatment, mainly on account of the annoying symptoms to which it gives rise in the patient, the consideration of the medical and surgical measures adapted for the relief of its morbid conditions, assumes special importance. Fortunately, the surgeon is here in a position, mainly through the employment of surgical means[1] it must be admitted, to attain excellent and often brilliant results.

Aside from the occasional employment in these cases, as well as in the other forms of nasal catarrh, of a general remedial course of treatment suited to the existing diathesis, and the indications for the employment of which will suggest themselves in each individual case, the question here arises, whether any of the special agents of the Pharmacopœia, that have been from time to time recommended as having a useful therapeutic effect upon the mucous membrane of the respiratory passages in a diseased condition, is in reality of great value. I believe that this is questionable. I have made use of many, and have never been able to convince myself that any one possessed a decided, specific effect. Cubebs, ammoniacum, muriate of ammonium, and perhaps sulphur, have given the best temporary, and sometimes permanent results. In each case, however, their use has been associated with that of local and direct treatment of the mucous membrane. The latter is of unquestionable value. If the disease is moderate in extent, and the hypertrophy of the tissues not excessive, complete resolution may be effected by the application of such astringent and resolvent solutions, in spray, as are specially indicated. Preliminary instrumental cleansing of the nasal passages will probably be requisite in the majority of instances; but the practitioner, bearing in mind that this may be a possible source of irritation, should always assure himself first that the removal of the secretions cannot be effected by the patient's blowing his nose, etc. The nasal spray apparatus, with the cleansing solution (see page 366), here renders effective service when its use is necessary. Occasionally it must be superseded by the posterior nasal syringe, when the secretions, especially at the vault of the pharynx, are thick and tenacious, or when the occlusion of the nasal passages anteriorly is so great that a spray cannot be forced through them. Following the cleansing process comes the next procedure, viz., the application of medicated spray, suited both in strength, amount, and nature to the individual case (see page 377); or, if solutions of astringents or other drugs are not well tolerated, the insufflation of the proper powder.

On the other hand, if the catarrhal process be first seen in its advanced stages, when a firmly organized neoplastic tissue exists in large degree, and seriously encroaches upon the nasal cavities, associated with a chronic inflammation involving the greater part of the naso-pharyngeal mucous membrane, the best that can be gained by the above plan of treatment will be the alleviation of some only of the more prominent symptoms, and more heroic measures will be required, chiefly the use of some means by which the hypertrophied membrane can be destroyed. Attempts to effect absorption of the neoplastic tissue, through the introduction of hollow bougies into the nasal passages, where they are left for a time *in situ* (Hoppe), or the use of sponge tents, metallic bougies (Wagner), and the like, fail to give more than temporary relief, and the surgeon is obliged to turn to one of the following destructive agents, viz., the forceps, nitric acid, chromic acid, glacial acetic acid, nitrate of silver, the actual or galvano-cautery, or the *écraseur.*[1]

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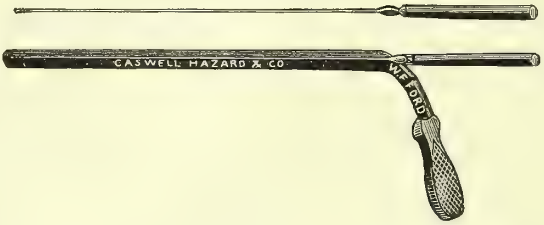
[1] Seiler, Surgical Treatment of Nasal Catarrh. Phila. Med. Times, No. 362. 1881.

Forceps, formerly commonly used in the nares for this purpose, have been justly supplanted by some one of the other means. The operation of tearing away portions of the hypertrophied tissue, over the turbinated bones, is harsh and attended by profuse hemorrhage.

Nitric acid has often served a good purpose in my hands. It is a powerful destructive agent, and with some care its action can be limited directly to the part to be treated. The guarded canula of Smith will perhaps here be of service. A small probe, its end wrapped in absorbent cotton and saturated with the acid, is passed through a suitable nasal speculum into the naris to be operated upon, and drawn along, or firmly pressed upon, the turbinated bone at the point of its greatest convexity, contact being kept up for a few seconds; the pain quickly passes away, and on withdrawing the probe the parts are seen to have become well whitened or blanched; moderate inflammatory reaction, with a slough of varying depth, follows, while the consolidation of the submucous structures by the hyperplastic results of the inflammatory process and the contraction of the cicatricial tissue, occupying the site of the destroyed parts, serves to reduce the hypertrophy and its resultant nasal obstruction in a most satisfactory manner. Frequently, one application answers all purposes in freeing the nasal passage to the extent of allowing of uninterrupted respiration. The process, however, may require repetition. This little operation is one that I very frequently employ, and one in which I have much confidence. Owing to the danger of an excess of acid flowing over the healthy parts, and the difficulty of controlling this in a locality hard of access, this caustic is not adapted for use in the destruction of the adenoid hypertrophies met with at the vault of the pharynx. Its use should be limited to the parts reached through the anterior nares.

Fig. 930.



Smith's guarded canula for applying nitric acid to the nasal passages.

Chromic acid is less painful in its use than nitric acid, but possesses no other special advantage over it. It is well adapted for treating the glandular hypertrophies located in the pharyngeal vault, the small acicular crystals being easily taken up upon a suitably curved, cotton-covered probe, and carried behind the velum to the desired point.

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[1] Gelatine bougies, moulded to a suitable form and medicated with various astringents, are advised by Guttman.

Glacial acetic acid is highly recommended by Bosworth and others as an application to the hypertrophied tissues located in the nasal passages, on account of its well-known affinity for epithelial cells, and its action on the localized hypertrophies of the superficial layers of the integument. It is certainly efficient in destroying tissue, and easy of application by means of the probe; it causes no secondary inflammation, nor too much destruction, and it gives rise to no excessive pain. I have used it also in many instances with complete satisfaction, and I regard it as specially adapted for the more recent and more moderate cases of hypertrophy.

Nitrate of silver, formerly, and even to-day, extensively employed in this class of cases as a destructive agent, does not sustain its reputation. It causes but a superficial slough, and the application is of necessity frequently repeated in treating hypertrophied tissue of any extent. Moreover, owing to its powerfully stimulating qualities, it excites cell-proliferation and causes structural changes that are not desirable.

After the use of any form of caustic in the nasal passages, immediately upon the withdrawal of the probe, the parts should be flooded with an alkaline solution; the subsequent treatment of the case, at least until the slough has separated and the resultant ulcer healed, is based upon ordinary principles of cleanliness.

The actual cautery is seldom used, and possesses no special value to commend it.

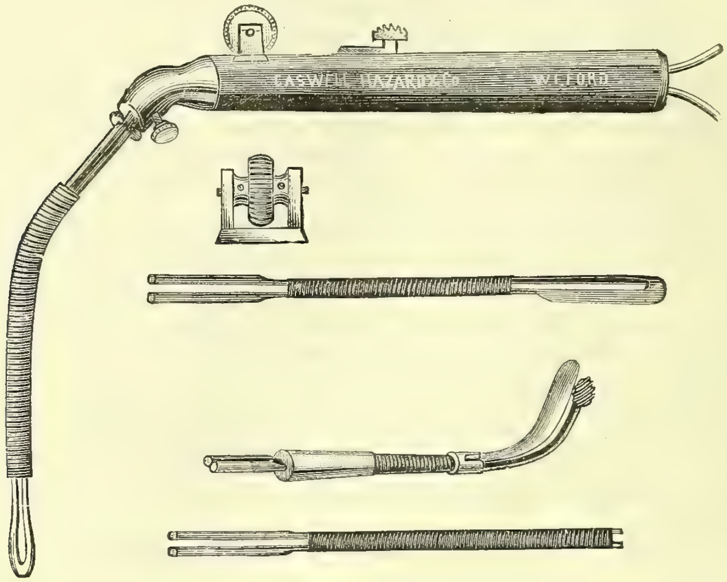
The galvano-cautery offers a most radical and efficient means of destroying the hypertrophic and vascular obstructions of both nares and upper pharyngeal space, and is to-day widely employed for this purpose. Its action is rapid, but complete, and its use is not excessively painful. I believe, however, that we may accomplish, in very many cases, the same results by the use of less heroic measures. When the hypertrophies are extensive, Seiler justly observes, that the knife should be at a cherry red when the incision is made, when there will be neither hemorrhage nor much pain. If the heat be too great, bleeding will follow the incision, and if not hot enough, the pain will be severe. The immediate result of the incision or cauterization is the formation of an eschar, and acute inflammation surrounding the burned portion of tissue; the ultimate result, the formation of bands of cicatricial tissue which by their contraction bind down the tissues, and thus relieve the stenosed condition of the nasal passage for which the operation has been undertaken. The form of instrument to be employed to effect a given purpose, depends upon the choice of the operator and the special indications. Many varieties of electrode and apparatus exist. Voltolini uses an electrode with a single wire-loop point; Michel, a wire-loop *écraseur;* Thudichum, a wire loop; Browne, a bullet-shaped electrode; Shurley and Bosworth, a slender knife-electrode. Probably as convenient forms of electrode and handle as can be obtained for general use are shown in the accompanying figures (Figs. 931, 932). As will be seen, they are adapted for the treatment of both the nasal passages and the vault of the pharynx.

To protect the nasal passage during the introduction of an electrode into the anterior nares, the ingenious speculum of Shurley, with its movable ivory slide to cover the septum, will be found convenient.

During galvano-cautery operations upon the tissues at the vault of the pharynx, it may be necessary, especially in patients with irritable throats, to tie the soft palate forwards, in the manner described upon page 364.

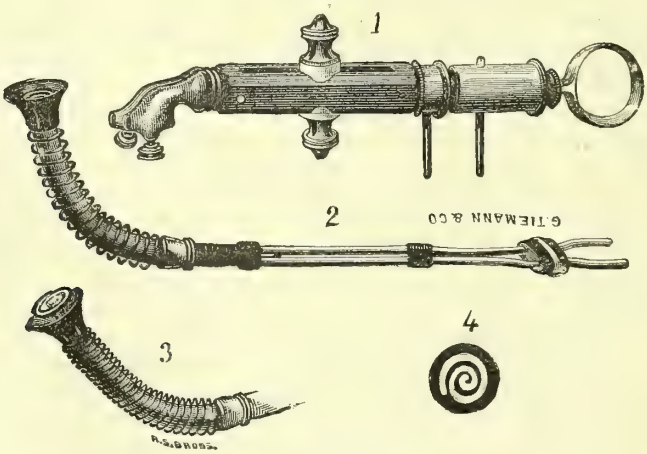
In many instances, the hypertrophy of the tissues over the inferior turbinated bone will be found to exist almost exclusively at its anterior extremity, and in such a case the procedure recommended by Jarvis will be found well adapted for its removal. The growths are usually sessile, but can be readily engaged in a loop of fine wire passed through the *écraseur* devised by this surgeon (see Fig. 933), if their base be first transfixed with a slightly curved needle until the point projects above the growth into the nasal cavity; the loop is then arranged in such a manner that both the portion of the needle projecting from the nostril and the needle's point are encircled by it, very much after the manner of a hare-lip suture; the wire is thus prevented from slipping off, and the hypertrophy is readily secured, and is

Fig. 931.



Nasal electrodes.

Fig. 932

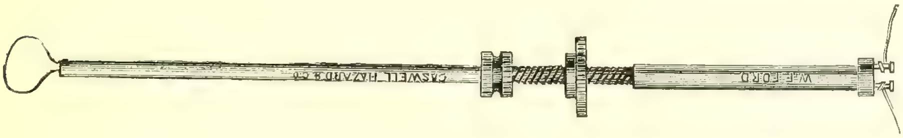


Nasal electrodes.

removed by screwing down the milled nut of the instrument and drawing the wire home. The little operation is quick and almost painless, as well as bloodless. The relief that it affords is great.

Excessive hypertrophy of the mucous membrane covering the posterior extremity of the inferior turbinated bone, and localized there, is no unusual condition, and may be of such an extent that the whole posterior naris is occluded by a rounded, sessile tumor of irregular surface, which grows downwards and backwards, until it rests partly upon the dorsum of the velum, and protrudes above into the upper pharyngeal space. It receives special mention here, because, owing to its peculiar position and shape, it cannot be safely reached and destroyed by any caustic method. The small wire *écraseur* of Jarvis here again certainly affords, when properly used, the most efficient and most satisfactory means of dealing with these localized hypertrophies, and of effecting their entire removal.[1]

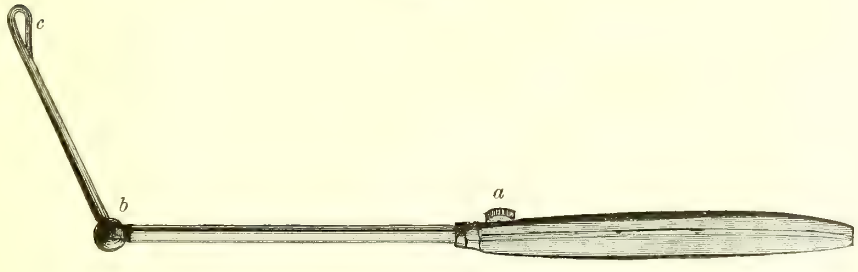
Fig. 933.



Jarvis's wire *écraseur.*

The instrument is light, and at the same time powerful; it can be passed through a narrowed nasal passage without difficulty, and, if the size and location of the hypertrophic tumor have been carefully studied previous to its introduction, and if the wire loop have been arranged accordingly, no great difficulty is experienced in ensnaring the growth. Slight traction on the instrument, and a few turns of the milled nut, will now secure it firmly, and the mass is then slowly cut through, to insure freedom from hemorrhage. The details of this little operation, which, if judged by its results, constitutes one of the more marked advances of recent rhinoscopic surgery, have been fully described by its originator in several recent articles.[2]

Fig. 934.



Nasal curette.

If the vault of the pharynx be involved in the disease, as is usually the case, especially in young subjects (adenoid vegetations or hypertrophies), active surgical treatment will be required, for sprays will be found ineffectual in producing any marked resorption of the hypertrophic masses. The choice practically lies between the use of the galvano-cautery, the curette, caustics, and, finally, the forceps. Other means are advised, such as the use of the sharp spoon—a cutting edge fastened to a finger-guard—the Jarvis wire-snare, modified for use in the pharyngeal vault, and the like; but they do not possess the advantages of the first-named instruments and methods. The use of the curette is indicated when the hypertrophy of the tissues extends broadly in the shape of small nodulated masses over the entire pharyngeal vault. Caustics are only to be employed when the hypertrophy is of limited extent, and, as has been stated, chromic acid is preferred. Forceps, curved at a suitable angle to be passed behind the velum, and furnished with cutting blades, are extensively employed by foreign operators. I have of late used them exclusively in many operations, and have been well satisfied with the results.

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[1] Seiler, Medical Record, October 29, 1881; Bosworth, Medical Record, July 9, 1881.

[2] Archives of Laryngology, vol. ii. No. 2 and vol. iii. No. 2; Transactions of the American Medical Association, 1881.

Atrophic Nasal Catarrh.—As the result of the process of intra-nasal hypertrophy described in the last section—in certain cases following it, when it has lasted some time, or, more rarely, occurring early in the disease, before hypertrophy is far advanced—*atrophic*, or as it is sometimes termed, *fetid rhinitis*, is developed. It is much rarer than the preceding varieties. Its *etiology* is as follows. The deposition of newly developed connective and elastic tissue in the deeper layers of the nasal mucous membrane, in hypertrophic rhinitis, leads to two results: first, by its mere presence and amount, it may press upon, cause atrophy of, and destroy function in, the glands and follicles which thickly stud the mucous membrane; this may occur early in the disease, but when seen at a later period, as commonly is the case, the process of atrophy in the glands and other tissues has a different explanation. I believe it to be then due to the contraction which takes place in the elastic and connective tissue above alluded to. The more firmly this becomes organized in the course of time, the more firmly it compresses and consequently destroys the function of the secreting glands and follicles, mainly and primarily the serous glands, and with them the mucous membrane in which they lie, and the submucous structures undergo atrophy, and even more. If the process be long continued, the effect of this constant pressure, aided by the pressure exerted by the inspissated secretions and hard crusts, upon the turbinated bones, is to cause an interstitial absorption, an atrophy, in them; the result is shown, in the course of time, in the abnormally wide, roomy nasal passage, and in the almost rudimentary appearance of the turbinated bones, especially the inferior. From the process of atrophy here described, to the condition accompanied by fetor, or to the form of rhinitis termed fetid, is but a step: the latter condition follows the former closely—indeed is part of it, if it has lasted any time—and I see no need, clinically, to make a distinction between the two.

Fetor is the direct result of the atrophy, in this way: the secretions are scanty and tenacious, as has been said, and become more and more so as atrophy of successive follicles and glands takes place. (The explanation is simple: the atrophic process has affected, first and chiefly, the serous glands, which are numerous in the nasal mucous membrane; their function is, as is well known, by their secretion to render the nasal mucus thin and watery; but this function being abolished by their gradual destruction, the mucus secreted by the mucous glands, large numbers of which still remain intact, is viscid and tenacious.) This secretion adheres to the mucous surfaces, and rapidly desiccates in the respiratory current of air. Large crusts and scabs thus readily form, and cling closely, in the nasal passages and at the vault of the pharynx. Impacted in the narrowed parts of the canals, pent up beneath the turbinated bones, and constantly growing in size by the addition of the secretions poured out beneath them and prevented from escaping, putrefactive changes set in, the matter thus imprisoned decomposes, and fetor is established. The irritation of the mucous membrane caused by the presence of these pent-up purulent discharges—for they rapidly change from muco-purulent to purulent—excites further discharge, and thus constantly aggravates the disease.[1]

The *symptoms* are mainly if not wholly due to the presence of the large, inspissated crusts of mucus in the nasal passages, with their resultant obstruction to the respiratory current, and to their decomposition, which gives rise to the fetid and offensive odor which is the main characteristic of the disease. Quantities of inspissated muco-pus mixed with blood, together with more or less fluid secretion of a muco-purulent character, are discharged daily. Pain and irritability of the mucous membrane are also complained of. Attacks of epistaxis (due to the erosions of the membrane caused by the mechanical irritation produced by the hard crusts of mucus), are not infrequent. In the later stages, when atrophy has taken place, there is less obstruction, and the sense of smell is either more markedly interfered with or probably abolished. When the vault of the pharynx is involved, the accumulations of the hard secretions at this point, give rise to pain, discomfort, and the sensation of a foreign body being present. *Pharyngitis sicca* is usually associated with the latter condition, and symptoms referable to this locality are manifested.

Rhinoscopic examination will seldom fail to show appearances characteristic of the disease: in its early stages, a dry and glazed mucous membrane, and as it progresses, constant increase in the crust-accumulation and change in the character of the diminished secretion, until the stage of atrophy is reached, when the nasal passage will be seen to be wide and roomy. Curiously enough, the mucous membrane of both the nares and pharynx, when cleansed of its overlying, thick and discolored mucous accumulations, presents a fairly healthy appearance.

Treatment.—Beyond question, atrophic nasal catarrh is an intractable affection; that it not infrequently baffles all, even persistent, efforts for its cure, clinical experience shows. Much, however, may be done by regular and faithful treatment, to mitigate at least the most offensive of its characteristics, and ultimate cure need not be despaired of if the case be seen in its earlier stages.

The first and most important indication is the thorough, regular, and careful removal of all crusts and inspissated secretions from the nasal passages and vault of the pharynx. This process, I repeat, must be regularly and persistently repeated at suitable, probably daily, intervals. Instrumental aid, such as that of the forceps, probe, brush, and the like, may occasionally be required, especially in the later stages, to insure thoroughness. The nasal spray-apparatus, used with a cleansing and disinfectant solution (page 367), may serve the purpose of cleanliness when once it has been established by other means. When more powerful measures are required, the anterior or posterior nasal syringe must be employed. In the earlier stages, remedies are suitable which from their nature tend to restore the normal secreting power of the mucous membrane, through stimulation of its glandular apparatus, probably by their irritant effect. Certain of them may be applied in solution, by means of the compressed-air spray, and others in powder.

Bosworth recommends especially:—

℞.—Pulv. sanguinariæ,
Pulv. myrrhæ, āā ʒj;
Lycopodii, ʒij. M.

℞.—Pulv. galangæ,
Pulv. amyli, āā ʒj. M.

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[1] See also the section on Ozæna.

Seiler[1] extols the use of a powder of nitrate of silver, or, in certain cases, a spray of an iron solution. Carbolic acid, salicylic acid, iodine, bromide of potassium, belladonna, and the like, are also employed.

In the later stages, after the cleansing process, the use of disinfectant solutions plays an important part, succeeded probably by the use of some powder containing pulverized iodoform. The treatment of so-called ozæna, as described in the next section, is also applicable here.

OZÆNA.—The affection which has just been described, atrophic, or as it is sometimes called in its later stages fetid, nasal catarrh, is precisely identical in its pathology, appearances, symptoms, and results, with the disease which is commonly termed *ozæna*. Of this I think there can be no doubt, certainly in the majority of cases. But it is possible, as claimed by Michel, that in exceptional instances the original seat of the disease may be in the accessory sinuses of the nose, and only ultimately lead to the changes described below. The term ozæna, however, as it is generally used—to indicate a disease, rather than describe a symptom, and to cover a class of nasal affections, varied in their causation, but all possessing one prominent symptom in common, viz., an intensely disagreeable smell or fetor, associated usually with a thick crust-formation in the nasal passage—leads to much misconception. Of these nasal diseases, syphilis, with its destructive inroads upon both the bones and cartilages of the organ, is the most common. But the same symptom is also present in other ulcerative affections of the parts, such as struma, lupus, and glanders, and it is even not wanting, in a lesser degree, in obstruction of the nasal passages from any cause, especially long retention of a foreign body, with resultant accumulation of the discharges and their decomposition. To class, however, all these affections under one name, on account of the similarity of one of their symptoms, is manifestly to vary widely from the truth, leads but to confusion, and detracts attention from their true nature, the correct appreciation of which is of importance both on diagnostic and therapeutic grounds. It seems to me preferable, therefore, to restrict the term ozæna—if it be deemed desirable to retain it—to those cases of ulcerative disease of the nose, such as syphilis, struma, lupus, etc., in which fetor is a prominent symptom, and is dependent upon necrosis of bone; and even then to use the term only with a qualifying adjective, as syphilitic ozæna, etc. The terms *catarrhus atrophicus ozænicans* and *rhinitis atrophica*, it may be mentioned, have both been suggested by foreign authorities to replace the name ozæna in the nomenclature of nasal diseases.

E. Fraenkel[2] informs us that, up to the present time, four reports of accurate post-mortem examinations in cases of rhinitis atrophica, or so-called ozæna, have been made, by Hartmann,[3] Gottstein,[4] Fraenkel, and Krause;[5] these all found large nasal cavities, and slight development of all the turbinated bones, and they agree also in the results of their microscopic investigations, which showed connective-tissue change in the mucous membrane, with partial degeneration of the secreting elements. Zaufal builds his theory, as to the causation of the disease, on the existence of these large cavities (which he considers to be congenital), and believes all subsequent changes in the mucous membrane, and the fetor, to be consecutive to their enlargement and to the consequent accumulation of the products of secretion. In this view he is supported by Hartmann and Martin.[6] Fraenkel differs from this view, and agrees with Gottstein and Schäffer in regarding the size of the naval cavities as the result of the last stage of a diffuse, at first hyperplastic, but subsequently atrophic, rhinitis (see page 386); and the results of two post-mortem examinations of his own agree with those of Gottstein and Krause. He does not, however, coincide with the latter[1] as to the similarity of the structural changes in ozæna with those of xerosis of the conjunctiva and callous stricture of the urethra, in both of which the odor of the secretion, if any, can be easily tested, and in neither of which has fetor been found as a symptom. His results lead him to believe that atrophy of the mucous membrane is necessary for the production of the fetor, and that the disappearance of Bowman's glands is an important factor. He adds that it is doubtful whether the atrophy always follows hypertrophy, or whether, as in the granular kidney, the process is not one in which there is at first no appreciable thickening of mucous membrane.

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[1] Med. and Surg. Reporter, April 19, 1884.

[2] Virchow's Archiv, Bd. lxxxvii. 4 Feb. 1882.

[3] Deutsch. med. Wochenschr., No. 13, 1878.

[4] Breslau aerztl. Zeitschrift. 1879.

[5] Virchow's Archiv, Bd. 85. 1881.

[6] De l'Ozène vrai. Paris, 1881.

The majority of authors thus agreeing as to the pathology of the affection, two interesting points—(1) as to the immediate cause of the distinctive, fetid smell which has been alluded to, and the views of some authorities in regard to which have been given, and (2) whether or no the disease has a constitutional origin—claim attention. Upon these points opinions vary. Cozzolino[2] believes that simple ozæna may exist in certain individuals who have naturally fetid secretions, as of the feet and axillæ; Hebdemus, that the fetor is the result of a gaseous exhalation from a mucous membrane deprived of secretion; Krause finds a sufficient cause for it in the fatty degeneration of the newly formed cell-proliferations, even while they are in intimate connection with their original soil and before their appearance on the surface, and in the rapid change of the fat into fatty acids, and consequent decomposition, as proved by the appearance of margarin crystals in the crusts, these fatty acids being the invariable products of the decomposition of albuminous matters; Fournié holds that it is caused by the constitutional state of the individual—a state which excites a morbidly odorous secretion in the glands of the Schneiderian membrane; while Fraenkel's theory is, that the cause is to be found in suppuration of the mucous membrane, and E. Fraenkel's, that the presence of micrococci and bacteria is the chief factor in its development.

Is atrophic catarrh or ozæna always a constitutional disease? Fraenkel does not believe that its existence proves any special dyscrasia, but foremost in the list of constitutional predispositions to which it may be referred, he would place scrofulosis and perhaps syphilis. Cozzolino holds that it is a result of chronic rhinitis, and never occurs but in scrofulous subjects; this Krause doubts, saying that there is no ground for assuming that the constitutional idiosyncrasy, or the constitutional predisposition in the individual, upon which the disease depends, has any connection with scrofula. The theory of a constitutional predisposition is also held by Fournié.

The appearances of the disease, as they are seen in the nasal passages, are similar, though exaggerated in degree, to those described as being incident to atrophic catarrh.

Treatment.—The treatment of the affection will not vary, in the main, from that recommended for atrophic catarrh. The essential point is to insure thorough cleansing of the parts and their subsequent disinfection (see pp. 387, 388). The agents employed to neutralize the fetor are numerous, including antiseptics from permanganate of potassium down to iodoform. Fournié recommends boracic acid or salicylate of sodium. The cotton-wool tampon is generally well spoken of. Zaufal uses it to remedy the enlargement of the nasal cavities; Gottstein employs it to stimulate secretion. Fournié believes that when the cotton-wool is introduced into the nostril, it acts in a Listerian manner, that is, it prevents the germs from the external air from penetrating into and acting on the mucus, already too prone to decompose; and Fraenkel advises astringents and the galvano-cautery as the most serviceable means against the atrophy.

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[1] Loc. cit.

[2] Rev. Mens. de Laryngol., 1 Nov. 1881.

The whole matter of treatment is summed up tersely by Kendal Franks,[1] to the effect that, if the theory that the disease is due to atrophy of the mucous membrane is correct, there can be as little question of curing the affection as there would be of causing the retrogression of a granular kidney, or of a cirrhotic liver. By the application of strong astringents to the already atrophied mucous membrane, nothing is to be gained, though if we were able to get the disease in its hypertrophic stage, theoretically we ought to be able to effect a return almost to the normal condition.

Rouge[2] holds the view that it is impossible to have an ozæna without some lesion of the skeleton of the nasal cavities—a view in which, as has been said, I do not coincide, although I agree with the majority of the conclusions upon which he bases it, and hold that they serve equally well to corroborate the opinion above expressed as to the true cause of the disease; he advises that the upper lip and nostrils should be lifted together by first freeing them by incisions through the mucous membrane of the mouth, and dividing the cartilages at their attachment to the upper jaws. The anterior bony nares are thus completely exposed, and a good view obtained of the interior of the nasal fossæ, together with ample space for the introduction of instruments and the removal of diseased bone.

SYPHILITIC AFFECTIONS OF THE NASAL PASSAGES.[3]—Syphilis may exhibit various manifestations in the nasal passages.

In the infant, the disease appears *congenitally*, under the form of an acute coryza, with its attendant symptoms of swelling of the mucous membrane, obstruction to nasal respiration, profuse discharge, and hoarse voice, together with other evidences of the disease, such as affections of the skin, excoriations of the anus, etc. The evil effects of the nasal obstruction, as shown in the ineffectual attempts of the child to nurse, and its consequent inanition, have been elsewhere detailed (see page 374). The condition often becomes one of grave import. In addition to the ordinary constitutional treatment of the primary disease, it becomes requisite, in such cases, to thoroughly clear the nasal passages of all accumulated discharges, by the careful use of a syringe, with a solution of borax, chlorate of potassium, or the like, in warm water. Soothing ointments may then be applied with a brush, with good effect. The disease usually yields to this plan, without recourse being necessary to more heroic measures or to more active medication.

Chancre of the nostril is occasionally met with; Watson,[4] Cutter, and others report instances of its occurrence.

The *secondary stages* of the acquired malady are occasionally characterized by an acute and persistent coryza, and, still more rarely, by superficial ulcerations of the mucous membrane. Mucous patches may appear about the orifices of the nostrils. The earlier symptoms of the disease are simply those of an uncomplicated nasal catarrh, from which it presents no points of diagnostic difference, and recourse, in attempting to establish its true nature, must always be had to the clinical history of the case. The ulcerations, slight as they are, are more characteristic; their progress is slow, and they are usually found upon the cartilaginous septum. Rarely do they extend to any extensive destruction of tissue or of neighboring parts, and never, if controlled by judicious treatment.

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[1] Dublin Jour. Med. Sci., April, 1882.

[2] Nouvelle Méthode Chirurgicale pour le Traitement Chirurgical de l'Ozène. Lausanne, 1873.

[3] See Schuster and Sanger, Vierteljahrsschr. für Derm. und Syph., Jahrg. iv. Heft i.–ii. 1877; and Mauriac on Naso-Pharyngeal Syphilis. Paris, 1880.

[4] Med. Times and Gaz., April 16, 1881.

The most destructive, the most common, and the most characteristic of the syphilitic affections of the nose, occur during the *tertiary period* of the disease—that is, at a date from five to fifteen years after the primary infection—and, as is the rule with the severer lesions of syphilis, are more apt to appear in broken-down, neglected, and strumous individuals. The ulceration, commencing in a gummatous periostitis, or in a localized gummy infiltration of the mucous membrane, rapidly becomes wide-spread and destructive, invading and destroying both cartilaginous and osseous structures, and eventuating in necrosis and discharge; permanent deformity, from sinking in of the nose, follows, from loss of its bony and cartilaginous supports. No part of the interior, or, in certain rare cases, the exterior of the organ, is sacred from the inroads of the disease. Vomer, perpendicular plate of ethmoid, cartilaginous septum, turbinated bones, the floor and walls of the nose, yield in turn. Crusts and necrotic bits of bone accumulate in the passages; a most intolerable fetor is developed; the discharge is stinking, bloody, and purulent; abscesses form, and may rupture externally, and the hard palate finally becomes perforated. In rare instances, serious consequences may still further follow from the extension of the destructive process to the interior of the cranial cavity, or from some incidental or accidental complication—lodgment of necrosed pieces of bone in the air passage or œsophagus.

The *diagnosis* of syphilitic disease of the nose is ordinarily not difficult; the clinical history of the case, the presence of the syphilitic cachexia, the appearance of the nasal ulcerations, and especially the detection with the probe of necrosed bone within the passages, together with the offensive odor and discharge, and the existence of ulcers in the pharynx and fauces, rarely leave room for doubt. Lupus, scrofula, tuberculosis, cancer, and the ulcers of the exanthemata, the only other main affections of the nose giving rise to ulceration (see page 392), are readily eliminated, in the absence of their characteristic appearances and constitutional symptoms. Special care must be taken not to confound cases of syphilis, attended, as they are, by an ozænic smell, with cases of simple ozæna, such as have been elsewhere described. The mistake is no unusual one, and the direful results of want of proper treatment, or the effects of mismanagement, in such instances, are well known.

Treatment.—The importance of prompt, efficient, and skilful treatment, both local and general, cannot be overestimated; the latter is always essential in controlling the disease; the former, of the utmost value in limiting its destructive course and hastening its cure. Iodide of potassium in full doses (gr. x, xx, to xxx, or more, three or four times daily), conjoined, if the necessary indications exist, with the administration of the preparations of iron, cod-liver oil, and the like, constitutes the sheet anchor of treatment, and its use is often attended with the most brilliant results. Mercury, I believe from experience, to be of less value in controlling the ulcerative action in this stage. The combined treatment may be preferred by some. Locally, the indications are to correct the offensive odor, check hypersecretion, and remove all the necrosed bone, which acts as a constant irritant. The first step is the thorough cleansing of the parts by means of a disinfectant solution (permanganate of potassium, liq. sodæ chlorinat., carbolic or salicylic acid, borax, creasote, etc.), used with the nasal douche, or, still better, some form of nasal syringe. The nasal spray-apparatus is rarely forcible enough in the stream that it throws to dislodge the thick and impacted accumulation of crusts, or to loosen necrosed bits of bone; indeed, both often require direct extraction at the hands of the surgeon, aided by forceps and probe. This cleansing process thoroughly accomplished, the state of cleanliness thus obtained must be maintained by the repetition of the syringing, by either surgeon or patient, as often as may be necessary—certainly, at the outset, each day. After each cleansing, powdered iodoform may be insufflated into both nostrils, and over all ulcerated surfaces, by means of Smith's insufflating tube or nasal powder-blower. Some prefer the immediate inhalation of the vapor of iodine, or the insufflation of Trousseau's mercurial powder. The first plan I believe to be the best. The importance of removing as soon as practicable all necrosed bone will be apparent. It acts as a foreign body, keeps up ulceration, and prevents reparative action. Its extraction by means, usually, of the polypus forceps, is a simple matter, and is governed by ordinary surgical rules. Goodwillie has reported good results in his treatment of such cases by grinding or cuttting away all dead bone with the burr of the dental engine, introduced through the nasal opening, and smoothing away all ragged and irregular surfaces that are left. The healing process and the duration of the disease are unquestionably considerably shortened by such a procedure.

Ulcerative Diseases of the Mucous Membrane of the Nose.—Aside from syphilis, which, as has been shown, may in its progress destroy not only the mucous membrane, but the cartilaginous and bony parts of the nose as well, and give rise to all the symptoms of a marked ozæna, other ulcerative diseases of the nasal mucous membrane exist, the commoner ones comparatively unimportant, the more serious fortunately rare. Both classes still remain to be considered. *Catarrhal ulcerations*, as they have been termed, but which are in reality never more than slight erosions, are not the rule in uncomplicated nasal catarrh, and are but rarely met with. Contrary to general assertion, the *eczematous* form of nasal ulcer, if it may be so termed, is not uncommon in children, and may be associated with eczema of the upper lip and cheeks. The crusts frequently form so thickly about the nasal opening, that it is occluded by them as well as by the attendant swelling of the mucous membrane, and much nasal obstruction to breathing and discomfort are thus caused. A deep, painful *fissure* at the lower part of the nasal meatus is furthermore no unusual result, if the condition be neglected. In either case, a constitutional course of treatment suited to the indications, and locally, complete cleanliness obtained by the daily injection of an alkaline solution, and the prevention of the re-accumulation of the crusts by the use of some unirritating ointment, such as that of the benzoated oxide of zinc, glycerine of borax, etc., will quickly relieve the affection. It is as a rule not associated with an ozænic smell, unless there be considerable and prolonged obstruction to the exit of the nasal secretions. *Traumatic* ulcers, the result of the mechanical irritation caused by the lodgment or pressure of foreign bodies within the nasal passages, quickly heal when the offending substance is once removed. Ulceration of the nasal mucous membrane occurs among workmen in arsenic (paper-hangings), and in those who are exposed to the fumes of chromic acid. A more serious form of ulceration, extending even to the destruction of the cartilages and bones, occasionally occurs among the *sequelæ of certain fevers* —measles, scarlatina, smallpox, and typhus—perhaps also in erysipelas and chronic pyæmia. The local symptoms are marked and leave no room for question as to the diagnosis. *Scorbutic ulcers* of the nose may occur. Buzzard[1] says that in confirmed scurvy, the slightest pressure suffices to open the skin and to give rise to an ulcer, whose edges are hard, thick, and shining, and the surface fungoid and bleeding, and that the lips and nostrils are occasionally the seat of this form of ulceration. An intolerably offensive odor is emitted, and the exhaustion attendant upon it is often fatal. Watson has called attention to the fact that in paresis of the fifth pair of nerves, ulceration of the mucous membrane of the nose may occur as the result of the disturbance of nutrition, associated with their sensory function (*neuro-paralytic ulcers*). He adds that little can be done in the way of local treatment.

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[1] Reynolds's System of Medicine, vol. i. p. 744.

Scrofulous ulcers, according to Fraenkel, frequently occur in the victims of scrofula, upon the nasal mucous membrane. At times, and as a rule, small, at other times they may penetrate deeply, and destroy both bones and cartilage. Special care is necessary, in order to differentiate them from similar ulcers of a syphilitic nature.

GLANDERS.—The source of glanders in the human subject can almost uniformly be traced to an accidental inoculation of the virus from an animal affected with the disease, for isolated instances only exist where it has been communicated from man to man. The mucous membranes, and first that of the nasal cavity, early manifest symptoms of inflammatory and ulcerative action. At the outset, and following the general lassitude, pain in the back and limbs, headache, and rigors, the discharge from the nose is of thin, viscid, and light-colored mucus only. Gradually, however, there appears in the acute form of the disease, swelling and redness of the organ and its adjacent parts, accompanied by severe pain; its upper portion is especially sensitive to the touch, exhibiting a diffuse, erysipelatous swelling. The nasal discharge now becomes of a thicker consistence, more purulent, of a brownish-yellow color, sanguineous and offensive. Distinct tubercles are frequently seen, situated especially upon the alæ, and the formation of pustules and ulcers in the mucous membrane of the nose may be distinguished in many instances in the more malignant forms. These terminate in involvement of the perichondrium and perforation of the septum.[1] The constitutional disturbances attendant upon these local manifestations are marked. Aside from those already mentioned, the pulse and temperature are high, and the respiration embarrassed; delirium occurs early; swellings of a red color upon the legs, and pustules about the face, follow, the original pustules assuming a purplish tint. Diarrhœa and profuse sweating, with restlessness and increased delirium, are but the forerunners of the end, exhaustion and death closing the scene.[2]

In chronic glanders, the nasal lesions do not differ essentially from those in the acute form of the disease just described. They run a longer course, however, and are sometimes entirely absent.

The treatment resolves itself, practically, into that of the general condition. Little can be done locally, aside from the injection of disinfectant solutions into the nasal cavities for the purposes of cleanliness. Applications of tincture of iodine or nitrate of silver have been advised by Bollinger.

LUPUS.—If lupus of the cutaneous surface, especially of the face, be not present, the diagnosis of lupoid ulcers within the nose is a matter of some difficulty, since they are readily confounded with like affections of syphilitic origin.[3] The points in differential diagnosis have been well stated by Durham. Attention must be directed to the history of the case, to the age of the patient, to the absence of other symptoms of syphilis, and especially of the characteristic cachexia which almost always accompanies the more serious syphilitic affections of the nose, and also to the comparative slowness with which the malady has progressed, and to the lateness of the period at which the bones have become affected.

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[1] Consult the excellent article by Bollinger, Ziemssen's Cyclopædia, vol. iii. p. 356.

[2] See Schilling, Medico-Chirurgical Transactions, 1830–31.

[3] See Moinée, Thèse de Paris, No. 236. 1877.

If the little tubercular infiltrations of lupus can be recognized, and the tubercles present a compact, granular appearance, the diagnosis is confirmed; and it is further strengthened if the disease progress slowly, and if there be a manifest disposition towards healing, here and there, even while the ulceration is extending; anti-syphilitic treatment may be employed as a means of assistance in the diagnosis. If an anterior rhinoscopic examination be made, small, reddish-looking tubercles can usually be seen early in the disease to stud the mucous membrane; these soon break down in ulceration, the ulcers preserving to some extent their tubercular character, and the apices of the tubercles being concealed by hard crusts. As the ulceration progresses, the cartilages become affected, the septum is perforated, one or both alæ are destroyed, and the nasal bones are implicated. Serious deformity may thus be caused.

The *treatment* of lupus has elsewhere been considered;[1] it may be here added, however, that when possible to do so, the lupus-tubercles in the nasal mucous membrane may be destroyed by means of a fine galvano-cautery point, or even the actual cautery. Chromic acid, caustic potassa, and chloride of zinc, have been recommended for the same purpose, but their action is more difficult to control. Ure advises the use, as a destructive agent, of a thick layer of a paste composed of chloride of zinc with two or three parts of gypsum, and a little alcohol. Following the destruction of the tubercular masses, the resulting ulcers and the inflammation may be treated upon the principles already laid down elsewhere in this article.

Tuberculosis of the nasal mucous membrane is regarded as a rare affection, and certainly is one to which attention has only been directed within very recent years. The number of cases as yet upon record is too small to furnish a basis for definite conclusions, or to clinically illustrate distinctive, diagnostic appearances in the ulcerations. The descriptions thus far given of the latter vary greatly, and although in many of the reported instances a careful microscopic examination has established beyond doubt their true pathological nature, in others this is open to grave suspicion. Following irregular and scattered granulations in the mucous membrane of the nose, ulcers are developed which are small, sometimes disseminated, but at other times confluent. They are superficial, with slightly thickened edges, and an irregular, unhealthy-looking base; they may occur at any point in the mucous membrane of the nasal passages, but are found especially over that of the septum, and are only observed in patients in whom physical examination will show pulmonary tuberculosis, probably in an advanced stage; even in such instances, their differentiation from the ulcerations of lupus, and occasionally of syphilis, becomes a matter of nice diagnosis.

The accessory cavities of the nose, the frontal sinus, antrum of Highmore, and ethmoidal cells, were never found to be tuberculous by Weichselbaum, in a careful post-mortem examination of some 164 tubercular subjects.[2]

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[1] See Vol. II. p. 644.

[2] Fraenkel (Ziemssen's Cyclopædia, vol. iv.) quotes Willigk's statistics. In the post-mortem examination of 476 tubercular patients, tuberculosis of the nasal septum was seen but once. Laveran (L'Union Médicale, 1877, Nos. 35 et 36) gives two cases of tuberculosis of the nose. Riedel (Deutsch. Zeitschrift für Chir., Bd. x. 1878) gives cases of tuberculosis of the nasal septum. See also Thornwaldt, Deutsch. Archiv für klin. Med., Bd. xxvii. S. 586; Weichselbaum, Allg. Wiener med. Zeitung, Nos. 27, 28, 1881. (The microscopic examination in two cases fully reported is here given.) Fraenkel, Centralblatt für med. Wissensch., No 27, 1881 (Statistics).

NASAL DIPHTHERIA.—It is still an open question whether diphtheria of the nasal mucous membrane is ever a primary disease. Schuller[1] believes that it may be, but the case offered in support of his views is at best but a doubtful one; Kohts[2] asserts that it sometimes is, and that its local manifestations may either remain limited to the nasal passages, or, originating there, may spread thence into the upper pharynx, pharynx, and larynx. The converse is, beyond question, the commoner occurrence, and the local membranous evidences of the affection must extend from below upwards, by a process of gradual progression, before they are found within the nasal passages. Aside from the constitutional treatment of the disease, no local measures are usually employed in the case of nasal involvement, aside from injections or sprays of alkaline and disinfectant solutions. The relief that these give to the obstruction in nasal respiration, caused by accumulated secretion and membrane, and the consequent comfort of the patient, certainly indicate their use in all cases, aside from any direct influence that they may have upon the progress of the disease.

Pseudo-membranes in the Nasal Passages.—I have on several occasions been called upon to remove tough membranous exudations from the nasal passages, where they were giving rise to more or less obstruction of the air current, and to the symptoms of a chronic coryza. These cases have occurred in young patients, usually small children, free beyond all question from diphtheritic taint. The affection is purely a local one, and the membranoid mass is the result of a collection of tough, inspissated mucus, holding entangled epithelial *débris*. The masses are usually moulded about and over the inferior turbinated bones, to which they cling tightly, and the special point of interest in these cases lies in their differentiation from the somewhat similar-looking productions of diphtheria in the same locality. The absence of all constitutional disturbance, and of all local, acute inflammatory appearances in either nose or throat, readily serves to stamp their true character.

SUBMUCOUS INFLAMMATION AND ABSCESS OF THE NASAL CAVITY.—True phlegmonous inflammation of the nose can hardly exist, owing to the peculiar anatomical arrangement of its structures. Fraenkel has, however, called attention to a form of acute inflammation which, it is true, occurs but rarely, but which resembles a phlegmonous inflammation closely in its character, involves the deeper structures and periosteum, and gives rise to all the results of phlegmon. It is seen especially after direct injuries to the nose, but may arise without known or appreciable cause. Its locality may vary. Usually one nasal passage alone is affected, and this at some point other than the septum. As soon as an abscess forms it should be opened.[3]

Pustules of acne and small furuncles are not infrequently developed just within the openings of the nostrils, and lead to the formation of small, circumscribed abscesses, attended with much pain and the local evidences of acute inflammation. An inflamed hair-bulb is a common starting-point for the development of furuncle. Once incised with a small tenotomy-knife, these abscesses quickly disappear.

CASES OF PROFUSE WATERY DISCHARGE from one or both nostrils, without appreciable local cause, are reported by Paget,[4] Althaus,[5] Lingard,[6] Tillaux,[7] and Spiers;[8] and others, in which the same condition was probably dependent upon catarrhal inflammation of the nose or its accessory cavities, by Carter,[1] Spencer Watson, and Hewan.[2] The discharged fluid is clear and colorless, free from smell and taste, of a specific gravity of 1004, and of alkaline reaction; it contains proteid matter, probably albumen, chloride of sodium, phosphates, and a slight trace of iron, but no grape-sugar. Its quantity varies, large amounts often flowing away during the day, either at intervals, continuously, drop by drop, or sometimes so quickly as to form a stream; it is increased by exertion or straining, or by holding the head forwards, and its duration has been, in the reported instances, from nine to eighteen months. In none of the cases has there been any evidence of general ill-health, or evidence of local disease of the nose. In two, there was the history of a blow upon the skull, preceding for some time the appearance of the flow. The cause and the source of this large flow of fluid are involved in some obscurity. Paget expressed the opinion that it might be derived from either a frontal or an ethmoidal sinus, from the sub-arachnoid space, or from the sac of the arachnoid membrane; although a subsequent autopsy in the case which he reported showed its source to be the antrum. Lingard believed that in his case some fracture of the cribriform plate of the ethmoid might possibly have taken place, and have allowed the escape of cerebro-spinal fluid; a suggestion which also would cover the case of Tillaux. Althaus, on the contrary, asserts that these cases may be explained by the withdrawal of nervous force from the sphere of the trifacial nerve. The nasal mucous membrane receives its nervous supply chiefly from the ophthalmic branch of the trifacial nerve, and from the spheno-palatine ganglion, the secretion from the mucous membrane being caused by the sympathetic, and regulated and inhibited by the fibres of the fifth nerve. Remove, he says, this inhibitory influence of the trifacial, so as to allow the sympathetic fibres to rule supreme, and hypersecretion of liquid is the result. Injury or inflammation of the nasal twig of the ophthalmic branch of the fifth nerve may then be regarded as a cause, if not the cause, in the examples of the affection thus far recorded; and this view, in regard to any case, would be still further established if there should be anæsthesia of the mucous membrane of the nose, or of some portion of it, on the side corresponding to the flow.

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[1] Archiv für Kinderheilk. N. F. Bd. iv. Jahrg. 1871, S. 331.

[2] Gerhardt, Handbuch der Kinderkrankheiten, Bd. iii. 2te Hälfte, S. 18.

[3] See also under Abscess of the Nasal Septum.

[4] Lancet, vol. ii. p. 773. 1878.

[5] Brit. Med. Journal, Dec. 7, 1878.

[6] Ibid., Dec. 21, 1878.

[7] Traité d'Anatomie Topographique, p. 56. Paris, 1877.

[8] Lancet, March 5, 1881.

The *treatment* that has been adopted in the few instances that are reported, consisting mainly of astringents locally, does not appear to have been attended with any marked success. If the theory of Althaus be correct, the use of the constant voltaic current is indicated, to restore the function of the trifacial nerve and thus check the excessive secretion. In one instance this has succeeded.

EPISTAXIS.

Hemorrhage from the nose, in which more than a moderate amount of blood is lost, is a very infrequent occurrence; that it may, however, give rise to serious danger, and even destroy life, is shown by the experience of many writers. Rhodius[3] relates an instance in which eighteen pounds of blood were lost within twenty-one and a half days; Martineau[4] one in which twelve pounds flowed away in sixty hours; and even seventy-five pounds have been known to be lost within a period of ten days.[5] Gross[6] has seen five fatal cases, in which death was caused either by imperfect plugging of the nostrils, or because the operation was not performed until the patient was exhausted by hemorrhage. Edwards reports likewise a fatal case of bleeding from the nose,[1] and Parker Smith[2] lost twelve out of nearly thirty cases of diphtheria, in which, on account of the age of the patient, it was impossible to tampon the posterior nares. Epistaxis, which it should be borne in mind is but a symptom, may be either *primary*, in other words, dependent upon some intra-nasal lesion, or *secondary*, the sequel of some general constitutional condition or diathesis.

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[1] Lancet, Nov. 30, 1878.

[2] Ibid.

[3] Obs. Med. Francof., 1576. (Obs. xc.)

[4] Morgagni, De sed. et caus. morb., lib. i. epist. xiv. 23.

[5] Act. Erudit. p. 205. Lipsiæ, 1688.

[6] Syst. of Surgery, sixth ed., vol. ii. page 283.

PRIMARY EPISTAXIS.—The common variety usually occurs from one nostril only, and is dependent upon direct violence or irritation. Blows, ulceration of the mucous membrane, and the presence of growths, especially when of a malignant character,[3] constitute efficient causes. Cloquet[4] mentions irritant gases and powders as giving rise to epistaxis, and finally idiosyncrasy, as shown in the peculiar results developed by the inhalation of certain odors, must not be forgotten. A very common, but not generally appreciated cause, lies in the existence of a small, seldom extensive erosion of the mucous membrane of the cartilaginous septum, just above the point of the former's junction with the skin. The term ulcer cannot be correctly applied to this lesion—certainly not in its earlier stages, and as commonly seen—for although there is of necessity some loss of substance, no marked excavation exists except in extreme cases. Catarrhal conditions may or may not coexist; they probably will, but it must be borne in mind that neither erosion nor ulceration is a feature of simple nasal catarrh. On the contrary, I believe that these erosions are always the result, primarily, of the direct mechanical irritation or injury caused by the forcible and repeated removal of the slight crusts of inspissated mucus which are formed in the first instance by various accidental circumstances at this point (a slight concavity here is not infrequent), the finger being the common instrument. The epithelial covering of the parts being thus once disturbed, the subsequent steps of the process—constant crust-renewal and gradually deepening ulceration—follow, until perforation of the septum, no infrequent accident, is the result.[5]

SECONDARY EPISTAXIS.—This variety may be either *active* or *passive*. Under the former head may be enumerated those bleedings which occur when for any reason there is a sudden determination of blood to the head. Mackenzie[6] discredits the old-time view, that the accident may be produced by low atmospheric tension at great heights, and Cloquet[7] says that it is possible to ascend passively to a considerable height, as in a balloon, without its occurrence.

Passive epistaxis is met with in an inveterate and dangerous form in the subjects of the hemorrhagic diathesis; it also occurs in purpura hemorrhagica, scurvy, and variola hemorrhagica. Mosler,[8] in eighty-one cases of leukæmia, records sixty-four examples of hemorrhage, and in thirty-five of these the bleeding was from the nose. In influenza, variola, measles, and scarlatina, and in remittent, typhoid, and relapsing fever, it may occur at the inception of the disease, during its course, or as introducing a crisis; more rarely it is seen in acute tuberculosis, trichinosis, and some other similar conditions. In simple anæmia it is very common. Mackenzie has seen it occur as a concomitant of a highly plethoric condition in children; but more commonly in those of an ill-nourished, strumous constitution. As the result of a gouty or arthritic diathesis, in children, it is not unknown.[1] At puberty, especially in males, it is very frequent. Furthermore, any morbid condition which interferes with the venous circulation, or increases the pressure within the arterial system, alters the tension in the bloodvessels of the nose, and thus predisposes to passive hemorrhage. Epistaxis due to emphysema, heart-disease (Durozier), or whooping-cough, is thus often seen, and it may likewise depend upon diseases of the kidneys, spleen, or liver. (Boyce.) Pressure upon the venous trunks by tumors of the neck or chest, may also produce like results.

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[1] Transactions of the Mississippi Medical Journal Association, 1881.

[2] Watson, Diseases of the Nose, page 51. London, 1875.

[3] Virchow, Krankhaften Geschwülste, Bd. iii. S. 463.

[4] Osphrésiologie, p. 550. 1821.

[5] Lefferts, Medical News, January 28, 1882; Little, New York Hospital Gazette, March 8, 1879.

[6] Lancet, November 10, 1877.

[7] Op. cit., p. 560.

[8] Die Pathologie und Therapie der Leukämie. Berlin, 1872.

Those passive hemorrhages from the nose which have been termed *vicarious*, possess a peculiar interest. Epistaxis may appear vicariously for other customary hemorrhages, especially those of a hemorrhoidal character, or in place of menstruation, and in both cases may return at regular intervals.[2] Fricker,[3] Obermeier,[4] and Sommer[5] all report interesting cases of the latter form. Kussmaul[6] saw periodical epistaxis in a woman having no uterus. The deductions to be drawn from these observations are, however, it must be stated, denied by Puech,[7] who shows, from the statistics of one hundred cases, that the nasal mucous membrane is least frequently the seat of a vicarious catamenial flow.

Finally, passive hemorrhage from the nose is said to have sometimes prevailed epidemically,[8] and that habitual nose-bleed is hereditary in some families, is apparently shown by the observations of Babington.[9]

Symptoms of Epistaxis.—The symptoms of an attack are evident. The patient will complain of a sensation of pressure in the head, sometimes of dizziness and a feeling of warmth, and of fulness and tickling in the nose. The flow having commenced, may proceed from both nostrils, as in scurvy, purpura, etc., or from one only, as is commonly the case, and its amount is very variable; usually it runs in drops, but it may pour out in the form of a small stream. Jets of blood are rarely seen. As a rule it ceases spontaneously, or with simple treatment, in a few moments, but, on the other hand, it may last for hours, or even days, and large quantities of blood may thus escape. Fraenkel calls attention to the fact that hemorrhages dependent upon traumatic causes, or upon diseases of the nose, are much less likely to be accompanied by an abundant flow than those which are caused by other conditions. The blood is of a bright-red color, and coagulates readily. Where the flow is very rapid and prolonged, acute anæmia, with all its symptoms, may arise, and even death may occur. The pulse and appearance of the patient must then be carefully watched, especially if fainting or other evidences of exsanguination are present.

Diagnosis.—There is usually no difficulty in arriving at a correct diagnosis as to the source of the bleeding, especially if a direct inspection of the nasal passage from which it is proceeding be made. The frequency with which it arises from the anterior portion of the nasal septum has been alluded to. Certain conditions may arise, however, to complicate the question of its origin. If the hemorrhage be profuse, or if it occur during sleep, while the patient is in the recumbent position, the blood may pass either into the œsophagus, and be swallowed, or into the larynx and trachea. In either case, its subsequent removal can only be accomplished either by vomiting or by coughing, and an attack of hæmatemesis or of hæmoptysis may thus be closely simulated. Köppe[1] relates the history of a case in which bleeding originated in the transverse sinus, and, there being disease of the cavity of the tympanum, the blood was discharged simultaneously through the nose and the external auditory canal. In those rare cases where it originates in either the frontal sinus, the antrum, or the ethmoidal or sphenoidal cells, the diagnosis as to exact locality is extremely difficult. Care is also required when the hemorrhage is profuse, and rapidly fills not only the affected nostril but the pharyngeal space as well. In this case blood appears at the opposite nostril, giving rise to the suspicion that its source is double, and at the mouth also. Finally, hemorrhage from the posterior parts of the nose is not only more difficult to locate, but its symptoms are more liable to be confounded with those of other conditions than when it arises from the anterior portion. In any of these very exceptional instances, careful observation and the history of the case will generally serve to render the diagnosis clear.

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[1] Guy's Hospital Reports, 1868, p. 39.

[2] Fraenkel, op. cit. (Ziemssen), vol. iv. p. 152.

[3] Würtemberg. med. Correspond.-Blatt, No. 21. 1844.

[4] Virchow's Archiv, Bd. liv. S. 435.

[5] Heidelberger klinische Annalen. Bd. x.

[6] Von dem Mangel, der Verkümmerung und Verdoppelung der Gebärmutter u. s. w. Würzburg, 1859.

[7] Gazette des Hôpitaux, p. 188. 1863.

[8] Morgagni, op. cit., lib. i. epist. xiv. 25; Cloquet, op. cit., p. 557.

[9] Lancet, vol. ii. 1865.

Prognosis.—This depends entirely upon the amount of blood lost before the patient is seen, the efficacy and promptness of treatment, and the nature, in certain instances, of the cause which gives rise to the epistaxis. In the great majority of cases, as has been stated, the accident is of a trivial nature, and the means available for its arrest being effectual, no danger is to be apprehended if they are promptly employed. Where, however, the epistaxis is symptomatic of some disease of grave significance, the prognosis will be dependent upon the nature of the latter, rather than upon that of its complication alone.

Treatment.—The *direct treatment* of epistaxis simply resolves itself into the selection and proper application, to the bleeding surfaces, of some one of a long list of either mechanical or medicinal means for the purpose of causing coagulation of the blood, which then, in the majority of instances, serves as a tampon in the nasal cavity, and leads to occlusion of the bleeding vessels.

Unless the hemorrhage be excessive, the simpler means may be first employed, not forgetting here, as in all instances, to reassure the patient, tranquillize his surroundings, and cause him to breathe quietly through the mouth, and to abstain from all efforts at blowing the nose. His position should be erect, with the head inclined forwards. The ala of the affected nostril may now be pressed strongly against the septum, and pressure kept up for a few moments, or the finger may be introduced into the nostril as far as possible, to act as a tampon. (Valsalva, Morgagni.) During either of these procedures, the arm corresponding to the bleeding side may be raised above the head (Négrier), and efforts made to excite spasm of the nasal bloodvessels through reflex action, by applying cold, in the form of ice, to the back of the neck, or even to the scrotum, in men, and to the breasts in women. The use of ice or other cold applications to the exterior of the nose, or to the forehead, and injections, or the pouring of cold water into the nose, are sometimes useful in the lighter cases, by exciting reflex spasm of the bloodvessels; but all injections have the common disadvantage, that they wash away the clots as fast as they are formed. I have in several instances used injections of hot water with good effect. Chapman[2] recommends the water-bag between the shoulders, the water being at a temperature of 115° F., on the principle of a derivative. Finally, Marin[3] states that, as the blood in epistaxis generally flows from one nostril only—and most frequently from the anterior third of one of the nasal fossæ—compressing the corresponding facial artery on the superior maxillary bone, near the ala of the nose, will usually check it. The well-known expedient of inserting a tight paper roll under the upper lip will be remembered. Compression of the common carotid artery upon the bleeding side is also recommended. If these simple means fail, the nasal passage may be tightly packed with small pledgets of lint, fastened to strings to facilitate removal, with plugs of borated cotton, or absorbent cotton medicated with various astringents, or with bibulous paper. Leeper[1] advises the use of soluble bougies containing some styptic, and Thompson and Smyly, the introduction of strips of lint for the purpose of absorbing fluid and favoring coagulation; Curtin[2] sprinkles these strips with tannin previous to their introduction, and Gilruth[3] soaks them in perchloride of iron; but Frank believes that their efficacy depends upon the compression of the parts which they exercise, rather than upon their astringent qualities, and recommends that they be twisted to a large size previous to their introduction. The insufflation into the nares of astringent powders, and the injection of solutions of various astringents, mineral or vegetable, such as alum, iron, zinc sulphate, acetate of lead, gallic or tannic acid, or decoctions of krameria, have long been employed. Créquy[4] has devised an excellent syringe for injecting the nostril: a canula, 2½ inches in length and with a rounded extremity, is fitted to an ordinary syringe, the canula being perforated its entire length by a series of small holes, in spiral succession, and directed backwards so as to emit small retrograde jets. The injected fluid is thus thrown upon the mucous surfaces of the passage, and does not pass into the pharynx. Injections are, however, if carelessly used, not devoid of danger. Malherbe[5] reports an instance where death from pulmonary gangrene followed pharyngitis and laryngo-bronchitis, the result of injections of perchloride of iron into the nasal cavities; and Gaillard[6] details a somewhat similar case.

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[1] Archiv für Ohrenheilk., Bd. ii. S. 181.

[2] Med. Mirror, Feb. 1, 1870.

[3] L'Union Médicale, 25 Mai, 1872.

Should the means thus far alluded to fail in checking the hemorrhage, or should it, for any reason, be deemed desirable not to wait for their somewhat slow action, both the posterior and anterior nares should be plugged. This operation is readily effected by means of a Bellocq's canula; or, in default of this, a flexible catheter, with the stylet removed and a string fastened to its eye, will answer the same purpose and can be used in the same way. Bellocq's canula, the instrument commonly employed, is undoubtedly familiar to every practitioner. The canula having been passed back into the nostril, as soon as the watch-spring which it incloses has been pushed forwards, and its rounded end appears behind the soft palate and enters the pharynx, the double string with which it is threaded is seized and drawn out of the mouth. A graduated, conical compress of lint is now attached to the double string, which is passed through its middle, and being guided in its passage behind the soft palate by the finger, is drawn tightly up into its proper position in the affected naris, by the simple withdrawal of the canula from the nose. The anterior plug is now introduced, and the two ends of the string tied over it, to hold all snug. All possibility of further hemorrhage is in this way effectually prevented. These plugs should not remain in position too long: Gross[7] mentions that he has seen several cases terminate fatally with low fever and delirium, from systemic poisoning produced by their too long retention. Colles has seen tetanus follow from the same cause, and Habershon[8] pyæmia.

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[1] Dub. Jour. Med. Sci., Nov. 1873, p. 364.

[2] Phila. Med. Times, Aug. 1, 1872.

[3] Lancet, vol. ii. p. 775. 1871.

[4] Dub. Jour. Med. Sci., Oct. 1877, p. 366.

[5] Jour. de Méd. de l'Ouest, tome xiv. p. 108. 1880.

[6] Courrier Médicale, tome xxxi. p. 238. 1881.

[7] Op. cit.

[8] Lancet, Feb. 27, 1875.

At the expiration of forty-eight hours, therefore, they should usually be removed, by the use of forceps and probe, and the affected nasal cavity should be carefully syringed out.

To accomplish the same purpose, but to obviate the disagreeable necessity of plugging the nares, as here described, several devices have been introduced. Kuchenmeister uses a rubber tube terminating in a rubber ball; the ball is forced through the nostril into the pharynx, distended with water injected through the tube and retained by a stopcock, and then pulled forwards. Others use a rubber tampon distended with air. Englisch uses two rubber balls connected by a tube; one ball remains at the anterior opening of the nasal passage and occludes it.[1] Frank[2] suggests that a bag of hog's intestine be moistened, passed into the nasal canal by means of a probe, and then injected or inflated; and, finally, Diday[3] extols the use of a thin caoutchouc bag, employed in the same way. The internal use of hæmostatics is not often called for during an attack of bleeding, but it is a common practice to prescribe them if it be at all prolonged. Perchloride of iron, acetate of lead, gallic or sulphuric acid, and opium, are thus employed. Sulphate of sodium is recommended by Heurze,[4] one or two drachms being given every three or four hours, the object being to increase the density of the blood. For the purpose of causing contraction of the arterioles, ergotine is undoubtedly the best remedy, used either by the mouth or, if time presses, subcutaneously. In extreme cases only is transfusion called for. Mosler relates a case of leukæmic nose-bleed, in which not only the attack, but also the return of the epistaxis, as well as the occurrence of any other hemorrhage, was prevented by this means. Morton likewise details an interesting case of the same nature.[5]

The question may be appropriately raised, in many cases of epistaxis, whether or no it is advisable to interfere at all with the processes of nature. Peyer gives the following rule for the guidance of the surgeon in such instances:[6] "Plethoric youths in whom an epistaxis is aborted are prone to be attacked by cephalalgia, otalgia, and various catarrhal affections. Any hemorrhage which is accompanied by debility, pallor, and coldness, must be considered as excessive, and in such cases the active aid of the physician is demanded." Mackenzie[7] tersely sums up other contra-indications. Where there is great venous obstruction, as in cardiac disease, emphysema, cirrhosis of the liver, etc.—or in females where the hemorrhinia is of a vicarious character—there is little demand for precipitate interference unless the bleeding has been very persistent. Examples exist in which mania,[8] epilepsy,[9] rheumatism, and dyspnœa,[10] have been cured or greatly alleviated by an attack of epistaxis. On the other hand, not only are immediate and also subsequent local treatment demanded in many instances, but constitutional indications are likewise to be met. An example is afforded in the habitual nose-bleed of anæmia, and others will suggest themselves.

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[1] Allg. Wien. med. Zeitung, S. 191. 1875.

[2] Grundsätze über d. Behandl. d. Krank. d. Menschen, u. s. w., Bd. vi. S. 145. Mannheim, 1797.

[3] Weber, Pitha und Billroth's Handbuch, Bd. iii. 1 Abth. 2 Lief. S. 187.

[4] Compend. d. pract. Med., IV. Auflage, S. 94.

[5] Am. Jour. Med. Sci., July, 1874.

[6] De Morbis Narium. Basileæ, 1766.

[7] Loc. cit.

[8] Van Swieten, Comment. in H. Boerhaave aphorismos, 1124.

[9] Hoffmann, De Epilepsia.

[10] Raymond, Traité des maladies qu'il est dangereux de guérir, p. 255.

STENOSIS OF THE NASAL PASSAGES.[1]

Aside from the causes which have thus far been mentioned, that may lead to the temporary or permanent occlusion of one or both nasal passages, narrowing or closure of these cavities is dependent upon a variety of abnormal conditions, some of which, chiefly those affecting the nasal septum, are now to be considered. Their general symptoms, aside from those which are due to the catarrhal inflammation of the mucous membrane, probably coexisting, and which have elsewhere been considered, are mainly, if not wholly, dependent upon the obstruction to free nasal respiration, which may exist or occur at any portion of the nasal tract, and they will consequently vary in their gravity and persistency, with the grade and nature of the occluding cause. They may best, perhaps, be studied collectively at this point. The stenosis may vary from a slight impediment only to the free passage of air through the nasal canals, producing in the patient a sensation of uneasiness and discomfort, to complete closure, with its attendant train of evils. Much will likewise depend upon the fact, of whether one or both nasal passages are involved, both as regards the intensity of the symptoms and the seriousness of the results. The latter have been carefully studied by Fraenkel[2] and others. When occlusion is complete, and in certain instances even when it is only partial, oral breathing becomes a confirmed habit, and the conditions of respiration are thereby materially altered for the worse. The evil effects are soon apparent, not only in disturbances in the respiratory organs and air-passages generally, but likewise in circulatory derangements, impaired quality of the blood, and interference with general nutrition and development, the diminution of the air supply to the lungs being, as Berkart[3] has shown, readily demonstrated by listening alternately to the chest of one who breathes through the mouth and to that of one who breathes through the nose. The true function of the nose, aside from the sense of smell, being to warm, purify, and moisten the inspiratory current in its course over the turbinated bones, and before it reaches the deeper respiratory passages, the abolition of this function must necessarily charge the lungs with air which is not only raw and unwarmed,[4] but which likewise holds in suspension more or less dust, and is perhaps loaded with irritating particles. The dryness of the mouth and throat, the constant hyperæmia, and the predisposition to catarrhal inflammation of the mucous membrane, bear witness to the material disadvantages and results following upon nasal occlusion and enforced oral respiration. Its effect upon the character of the voice is well known, and the peculiar, disagreeable, nasal intonation, will be recognized as a prominent symptom and diagnostic sign of the condition. Meyer[5] has pointed out that when obstruction is complete, the letters "m" and "n" become perverted into "b" and "d"; and Löwenberg[6] dwells at some length upon the causes of this substitution. The character of the voice is thus altered for the worse: its quality is notably changed, its head-notes are abolished, and it becomes flat and nasal. Toynbee first demonstrated, I believe, through a series of carefully conducted experiments, the altered condition of atmospheric pressure in the fauces and ears when swallowing with closed nostrils; and Lucae[1] has called attention to the fact, that, when the nose is occluded, every act of swallowing repeats Toynbee's experiments. Both tympanic membranes are thus abnormally stretched, and the continuance of the process can but lead to injurious results as regards the hearing power. The manner in which these changes are produced has also been studied by Roe.[2] Occlusion, or a stenosed condition of the nasal cavities, when existing in the infant at the breast, possesses a peculiar and pressing significance; here even a simple "cold in the head," with its attendant hyperæmia and swelling of the mucous membrane, creates an element of danger. Both Billard[3] and Rayer[4] have shown us that under these circumstances the proper nutrition of the infant becomes almost an impossibility; every attempt to take and hold the breast is incompatible with the enforced oral respiration; the child, if the attempt be persisted in, soon reaches a point of suffocation which obliges it to desist, and use the mouth for respiratory purposes.

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[1] Consult also Lennox Browne, On Obstructions in the Nasal Fossæ (British Medical Journal, August 24, 1878); Ziem, On partial or total Occlusion of the Nose (Monatssch. für Ohrenheilk., No. 2, 1879); Ganghofner, The Anomalies and Narrowings of the Upper Air-Passages (Vierteljahrsschrift für pract. Heilk., Bd. cxli. 1879); Roser, On Deviation of the Nasal Septum (Monatssch. für Ohrenheilk., No. 4, 1881); Péan, idem (Centralblatt für Chir., No. 46, 1880).

[2] Op. cit. (Ziemssen), vol. iv. p. 103.

[3] Asthma, its Pathology and Treatment. London, 1878.

[4] Milne Edwards has shown, by experiment, that it is raised 2° in temperature when respired through the nose.

[5] Med.-Chir. Transactions, vol. liii. p. 191. London, 1870.

[6] Les Tumeurs adénoides du Pharynx nasal. Paris, 1879.

In the coryza of the new-born, then, direct and immediate treatment becomes a necessity. That by means of astringent applications has already been alluded to. Hoppe[5] uses hollow bougies as dilators, if the narrowing is not extreme, and thus by admitting air to the lungs while the mouth is closed over the breast, renders nursing possible; he also recommends forcible distension of the passages by means of slender forceps, a procedure that will hardly meet with general acceptation. Artificial feeding by means of the œsophageal tube, is advised by Kussmaul in extreme cases, and according to Fraenkel was successfully employed by Thiersch, in the case of his own child. The former author, also, after stating the fact, that a healthy infant during sleep always holds the mouth closed, and relies upon the nose for purposes of respiration, the tongue resting upon the hard palate, shows that, if under these circumstances occlusion of the nasal passages takes place, asthmatic attacks occur as soon as sleep overtakes the patient. Asleep or awake, the vigorous attempts at inspiration, in nurslings affected with coryza, may be followed by acute hyperæmia of the lungs, and herein also may lie the explanation of the sudden suffocative attacks. The violent efforts at inspiration, under these circumstances, have, moreover, been known to produce urgent dyspnœa, through the "swallowing of the tongue," so called. Such instances are reported by Cohen and Stammer, and Bouchut[6] has also called attention to the fact. Hauner[7] asserts that such cases have not only been mistaken for, but treated as, true croup. Paroxysmal asthma, and even sudden attacks of asphyxia, are not confined alone to children the subjects of nasal stenosis. Under certain conditions, the same attacks may occur in the adult.

Roe[8] points out that there are two modes in which nasal disease may provoke an attack. 1. The most frequent form results from a narrowing or occlusion of the nasal passages by hypertrophied tissue or nasal polypi. 2. Another form is induced by disease of the pituitary mucous membrane, unassociated with hypertrophy or polypi. The first, he thinks, is both mechanical and nerve-reflex in its character, whilst the second is purely reflex. It is a noticeable fact, that nasal polypi and hypertrophied tissue, when inducing asthma, are almost invariably located on the posterior end of the turbinated bone, the area that has been likened by Dr. Mackenzie to the sensitive cough-centres found in the pharynx and larynx. This fact explains the more frequent occurrence of asthma at night in those persons who suffer with hypertrophic nasal catarrh. At the posterior end of the inferior turbinated bone, the cavernous erectile tissue is much thicker and more dilatable than at the anterior; consequently, when in the recumbent position, the gravitation of fluid distends this portion of tissue, and, together with the accumulation of secretion, occludes the passage; or reflex irritation of the air-passages results, and the attack comes on. Dr. Roe appends several cases in which treatment applied to the nose cured the asthma. He advocates removal of the hypertrophied turbinated bones by the nasal bone-scissors, and of the hypertrophied tissue by Jarvis's snare.

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[1] Archiv der Ohrenheilk., Bd. iv. S. 188. 1867–8.

[2] Medical Record, April 30, 1881.

[3] Traité des Maladies des Enfants; 2e éd., p. 480.

[4] Note sur le Coryza des Enfants à la Mamelle. Paris, 1820.

[5] Neue Zeitung für Med., 1850.

[6] Traité prat. des Mal. des Nouveau-nés, 5e éd. Paris, 1867.

[7] Jahrbuch für Kinderheilkunde, V. Jahrg., S. 73. 1862.

[8] Report of Annual Meeting of the American Medical Association, June, 1883.

Traube[1] relates two interesting cases in which every inspiration was accompanied by a pressing together of the alæ of the nose, instead of a normal dilatation, causing nasal stridor and difficult respiration. This phenomenon he attributes to the beginning of paralysis of the respiratory nervous system, and regards the condition as a fatal one, unless properly treated.

Still further but less serious results affect the nasal organ directly when its passages are rendered more or less impermeable. These need but be alluded to. The inspired current of air is unable, in many instances, owing to the amount of obstruction presented to its entrance, to penetrate to the upper part of the nasal cavities and reach the seat of the distribution of the terminal expansions of the olfactory nerve. The sense of smell is thus blunted in direct proportion to the amount of interference with the entrance and passage of the air current charged with odoriferous particles. The same obstruction, again, by preventing or interfering with the expulsive force of the expiratory current, prevents the removal of the usually abnormal amount of secretion, either by blowing the nose or otherwise; its accumulation is in turn an efficient factor in producing obstruction; and a "vicious circle," as it has been termed, is thus established. The symptoms, then, of nasal stenosis may be thus summarized: inability to breathe through the nose, and consequent impairment of the sense of smell, with its accompanying absence of the perception of flavors, hoarseness and disturbance of speech, respiratory obstruction, asthma, sudden asphyxia, inability to remove the nasal secretions, dryness of the pharynx, a sense of fulness and pressure about the nasal and frontal regions, more or less persistent frontal headache, weakness of the conjunctivæ, a constantly open mouth—altering, in children, the cast of the countenance—and, finally, a predisposition to catarrhal inflammation of the respiratory mucous membrane upon the slightest exposure, or on any unfavorable change in the weather. As giving rise to the physical conditions which produce the results here described, a number and variety of causes, as has been stated, can be enumerated. Some, mainly those dependent upon the results of catarrhal inflammation of the nasal mucous membrane, have already been considered. Others still remain, of even more serious import, and will be discussed in detail.

Closure of the Nostrils.

Closure of the nostrils may be the result of either congenital malformation, disease, or accident. The former is rare, much rarer than like conditions in either anus or vagina. In the reported instances, there has either been an adhesion of the ala of the nostril to the septum, or it has been drawn down and attached to the upper lip; a continuation of the normal integument has covered in the nostril or nostrils, or the latter have been blocked up by a firm membrane. The effects of such occlusion are apparent. Fortunately, treatment is usually a simple matter, and the earlier it is undertaken the better. A simple, direct incision is often all that is needed, the opening thus made into the nasal passage being kept open and dilated by means of a strip of lint, until the healing process is completed. Where some deformity of the parts coexists with the occlusion, a more extensive dissection of tissue may be necessary. A like condition, the result of accident or disease, is more frequent; a common cause, of which I have seen and successfully treated two instances, is the loss of tissue and subsequent cicatricial contraction about the nasal openings following *smallpox.* Deep *burns* of the face produce the same result, and *fractures* of the nose, with laceration of the soft parts, and subsequent contraction during the healing process, are a like efficient cause. As a rule, in such instances, a small opening through the adventitious tissue will be found to exist, and may be simply dilated by means of compressed sponge, laminaria, or metallic bougies. In certain cases this treatment must be supplemented by incisions, the nature and direction of which depend upon the deformity in the particular instance in which they are undertaken. Constant repetition of the dilating process will always be found necessary to prevent recontraction.

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[1] Verhandlg. der Berliner med. Gesellsch., Bd. ii. S. 141. 1869–71.

Affections of the Septum.

The septum itself is liable to various affections, which play an important part in producing either temporary or permanent stenosis.

Extravasations of blood[1] occur, as the direct result of injury, beneath the mucous membrane on one or both sides of the cartilaginous portion of the septum. The resulting tumor is frequently large, with a broad base, and of a dark, congested color; the surrounding induration and the tension are marked, and often mask any sense of fluctuation. The rapidity with which the tumor forms after the accident, and the history of the case, with direct inspection of the parts, render the diagnosis easy. Inflammation and suppuration may generally be prevented, and resorption facilitated, by the adoption of strict antiphlogistic measures. Incisions are not often required—never unless the amount of extravasated blood be large and the obstruction to nasal respiration great.

Abscess of Septum.—Should these measures fail, acute abscess of the septum may result. Although this condition is usually the direct result of injury, and is not preceded by any marked extravasation of blood—I have never seen it arise spontaneously, in connection, for instance, with scrofula, or subsequently to the exanthemata, smallpox, measles, or scarlatina—the attendant tumefaction and inflammation are not always confined to the nasal cavities, the whole nose, cheeks and neighboring parts being not infrequently involved, especially at an early stage of the process. The tumor in the nose, which is always—apparently, at least—bilateral, presents a smooth, reddish appearance, is tender on pressure, and is seen at the lower part of the septum, shading off above and behind into the contiguous mucous membrane. Fluctuation is distinct, and is often felt on both sides of the septum, and through it; the latter is always the case if there is perforation of the cartilage, a not unusual result, especially if treatment has been delayed. I have never seen the inflammation spread to the frontal sinus or lachrymal passages. With this condition there is some febrile movement, and much local pain and distress. The treatment consists in opening the abscess by direct and free incision, with thorough evacuation of its contents. The longer the delay, the greater is the risk of the periosteum or the perichondrium being involved, with resulting necrosis. The incision, which rapidly closes, must be kept open for a few days until tumefaction has subsided. Bad results do not follow, even in cases where the cartilage has been perforated; the mucous membrane heals kindly over the small loss of substance without leaving any external deficiency.

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[1] Fleming, Dublin Quart. Jour. Med. Science, vol. iv. pp. 16–28.

Acute abscess complicated with a small aneurism has been observed by Thudichum[1] in one instance. In opening the abscess the aneurism was also opened, and the free bleeding could only be checked by means of the galvano-cautery.

Chronic abscess of the septum, with perforation of the cartilage, may occur in syphilitic or scrofulous subjects, and may even exist without known assignable cause. It is unilateral, its progress is slow and insidious, and its symptoms slight, the patient often being unaware that it exists; no marked inflammation accompanies it, and, externally, the nose gives no evidence of its presence. The ulcerative destruction of the cartilaginous septum which follows, is, however, serious, and one large orifice or several small perforations result, the former being the rule. Such cases are not unfrequently examined long after the subsidence of all of the symptoms, and when the existence of the perforation through the septum is the only guide to the surgeon as to the nature of the earlier affection. Perforation of the nasal septum, it may here be remarked, should not always be regarded as syphilitic in its origin, the result of the breaking down of a gumma. In many instances, probably, the true cause lies in the direct mechanical irritation caused by the patient, usually the subject of nasal catarrh, in constantly endeavoring to remove hardened secretions from the anterior portion of the septum. Such cases are not at all uncommon, and are elsewhere alluded to in this article. I cannot believe, with Cohen, that there is even a probability that, in a fair proportion of instances, the perforation has resulted during the course of a syphilitic coryza which has occurred in early infancy. Still less do I believe that these perforations are congenital, even though they be met with independently of any history of local disease within the patient's memory.

Early incision of these abscesses is imperative, and a guarded prognosis should be given. Perforation of the septum is the rule; and, although no external deformity of the nose has ever followed in my experience, the condition is one that, in many respects, is disagreeable in its results. Plastic operations for the closure of the deficiency, although they have been undertaken, are rarely if ever attended with success. Constitutional treatment, suitable to the indications presented in individual cases, is all-important.

SYPHILITIC INDURATION of one or commonly both sides of the septum, due primarily, in all probability, to disease of the perichondrium, without any marked inflammatory symptoms, and with no evidence at any part of its course of the formation of abscess, may exist, and may constitute an efficient cause of nasal obstruction. I have met with it in several instances. The diagnosis rests mainly upon the indurated character of the swelling, and upon the absence of all signs of excessive inflammation. Its differentiation from cartilaginous outgrowth of the septum, and even from deflection of the cartilage, should the induration be unilateral, demands some care. Its rapid subsidence under the use of an anti-syphilitic treatment is the rule, and confirms the diagnosis. I have had no experience in the injection into the substance of these swellings, of solutions of iodine and iodide of potassium, ergot, or carbolic acid. External applications are of little avail.

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[1] Lancet, April 17, 1880.

Submucous infiltration of the sides of the septum, to which attention was first called by Cohen,[1] is a not unusual complication in a large proportion of cases of chronic catarrhal inflammation of the nasal mucous membrane, and, if excessive, produces in a marked degree the symptoms of nasal stenosis. An examination with the rhinoscope shows that a tumid mass exists on either side of the septum and is confined to its posterior portion, of a whitish color, that is markedly distinct from the red color of the adjacent mucous membrane; it does not always, as asserted, occupy the lower portion of the septum, extending thence upwards, the reverse being, to say the least, very commonly seen. The affection is usually symmetrical; the masses are ovoid in outline, and much resemble nasal polypi. They appear to be œdematous projections of the mucous membrane from accumulation beneath it of serum, sero-mucus, or fibrin, and are best treated, according to Cohen, by tearing away portions of the masses by forceps carried up behind the palate, or introduced through the nostril, as the case may best permit, the operation being performed under the guidance of the rhinoscopic mirror. Hemorrhage is slight. The parts, after the operation, should be cauterized. Sometimes puncturing these masses with a curved lancet suffices. Finally, the galvanocautery affords an appropriate means for their destruction.

Deflection or deviation of the septum from the normal, median line, may be due to an abnormality, not uncommon in either its bony or cartilaginous portions, or may occur as the result of a fracture or displacement of the septum, the effect of direct violence.[2] In such cases, the cartilaginous septum is that which is most frequently displaced, and usually at the point of its articulation with the bony septum; next in point of frequency, the perpendicular nasal plate is broken, and especially where it approaches the vomer. The force of the concussion rarely reaches the latter, the perpendicular plate giving away first and easily. Proportionate to the amount of displacement will be the degree of obstruction to the nasal passages; a depression of the cartilage forming the ridge of the nose is necessarily accompanied with a corresponding degree of lateral displacement, with or without fracture of its perpendicular portion, and produces therefore not only great deformity, but sometimes complete flattening of the end of the nose, aside from complete obstruction of the nostrils.[3] The results of such fracture and displacement must not, however, be confounded with a deflected septum the result of congenital or acquired abnormality. The clinical history will assist in making the differential diagnosis. As a matter of fact, the nasal septum is rarely found perfectly straight, but exhibits a slight inclination either to one side or the other, usually the left. Owing to its composite nature, its errors of position are furthermore not of one kind; thus, deviations occur in the perpendicular plate of the ethmoid bone, at the ethmo-vomerine suture, and in the superior maxilla; and in the living subject they are also seen, and very commonly, in the triangular cartilage. All of the above-mentioned forms may exist separately, or together. The frequency of these deviations from the normal standard is shown in a study by Allen[4] of 58 adult crania; of these, only 18 exhibited normal nasal cavities, while in the remaining 40, 19 were found in which the curvature was so great as to cause the septum to lie in contact with the superior and middle turbinated bones; and Semeleder, in an examination of 49 skulls, found that the septum was straight in only 10, bent towards the left in 20, towards the right in 15, and in 4 was so twisted that it resembled the letter S in shape.

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[1] Diseases of the Throat, 2d edition.

[2] See page 409, *infra*.

[3] Hamilton, Fractures and Dislocations, 3d ed. 1866.

[4] Am. Jour. Med. Sci., Jan. 1880.

As a rule, the deflected part will be found to affect principally the cartilaginous septum, and to exist at the anterior portion of the latter. Such deviations, however great they may be, but rarely deform the external contour of the nose. When excessive, as the patient develops, the abnormality in the position of the septum turns the nose to one side, and narrows or occludes one or both nostrils. Although probably, in the majority of instances, the conditions here described are congenital, there can be no question but that, in certain cases, deflection or deformity is produced by the common practice of pressing more firmly on one side than the other in blowing the nose. Béclard explains it by the habit of wiping the nose with the right hand, the deflection being more often to the left than to the right. Be the cause as it may, the condition is an exceedingly common one, and if excessive, it produces such an amount of nasal obstruction, and gives rise to such distressing symptoms, that surgical treatment for its relief is always indicated. Diagnosis is not difficult; the appearance of the occluding mass and its feeling to the touch establish its nature, and this is further shown by an inspection of the unaffected cavity of the nose, which will show a concavity corresponding to the convexity upon the narrowed side. The cure of the condition is attained by various means, all having however for their object the replacement of the cartilaginous septum in the median line, and its retention there, or the removal of the offending portion.

Chassaignac[1] resorted to subperiosteal resection of the deviated portion. An incision was made through the mucous membrane in an antero-posterior direction, low down towards the floor of the nostril on the affected side; the membrane was raised from the cartilage by means of a small spatula, and the convexity of the cartilage then cut away in slices until sufficiently thinned to allow of its being pushed back into its normal position; the mucous membrane was then replaced, and the cartilage held in its new position by a sponge inserted in the nostril. Rupprecht,[2] when the deviation is caused by an abrupt curve or bulging, uses a sharp pair of forceps with blades so arranged as to cut out the affected portion of the septum; a communication is thus established between the two sides of the nasal cavity, and, according to the inventor, the permeability of the closed side is also restored. Blandin[3] perforates the septum in the deflected portion with a like punch. Steele[4] makes a stellated division of the mucous membrane and cartilage, then forcibly replaces the divided septum, and retains it in position by ivory or wooden plugs introduced into the nostrils. The division of the cartilage destroys in a great measure its resiliency, and the plugs are more to give support than to exert pressure. The instrument by means of which this is effected is a stout forceps, shod on one blade with knives set in stellar form; the two blades are united after the manner of obstetrical forceps, to facilitate introduction and withdrawal. The great advantage of the latter operation is, that it takes no portion of the septum away, as is the case in both of the former; and though deformity of the nose never follows the removal in these instances of a small portion of the septum, the effects of the resulting artificial perforation are disagreeable in numerous ways (whistling noise during respiration through the nose, constant collection and drying of the secretions upon the edges of the perforation, tendency to superficial ulceration, etc.), and should therefore be avoided if possible. Pancoast has separated the cartilaginous from the bony portion of the septum by subcutaneous division with a tenotome, and then replaced it in its normal position, pulling the nose to the opposite side and holding it with adhesive strips. Other surgeons have divided the nose in the median line and resected the septum. The indications presented in individual cases must guide the operator in his selection from these means.

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[1] Gaz. Hebdom., 11 Juin, 1869.

[2] Wien. med. Wochensch., S. 1157. 1868.

[3] Dict. Encyclopéd. des Sciences Méd., art. Nez.

[4] Archives of Laryngology, vol. iii. No. 1.

If the obstruction is due to a deflection or displacement of the cartilaginous septum, involving its whole or nearly whole length, the most successful operation for correcting it is probably that proposed by Adams.[1] In this method, the bent portion is forcibly broken or straightened by means of powerful forceps with parallel blades, one of which is introduced into each nostril; and when the nasal bones are displaced laterally and likewise depressed, these are raised also by carrying the blades of the forceps directly upwards. After the nose and its cartilage have thus been straightened, a retentive apparatus is employed, consisting of a steel screw-compressor, applied so as to support the septum; and, subsequently, ivory plugs are used to keep the nostrils moderately distended and to give support to the cartilaginous septum, not only during the healing process, but likewise for a time afterwards.

In conclusion, certain less heroic measures need but be alluded to: the simple insertion of metallic tubes in the nasal passages, thus exercising gentle dilatation and some compression, and the use of sponge tents, or of laminaria bougies, may, if their use be persisted in, especially in young subjects, bring forth good results, provided that the amount of deviation is not excessive.

FRACTURES AND DISLOCATIONS OF THE NASAL SEPTUM.—The treatment of these injuries is usually discouraging, as they are commonly followed by permanent deformity, which is, however, rarely great. Hamilton doubts whether a partition so thin and unsupported, can ever be well adjusted and maintained by artificial means, but advises that each nostril should be plugged carefully and equally with pledgets of lint, and the outside of the nose then covered completely with a nicely-moulded gutta-percha splint or case, which ought to be made to press snugly upon the sides; these dressings should be permitted to remain for several weeks, or until the cure is completed. This mode of procedure must be modified and varied to suit individual indications.

Fracture of the nasal septum, if extensive, and unless carefully treated at the time of the accident, may by its displacement and subsequent deformity seriously occlude the nasal passages. A common form of the lesion is the tearing away and lateral displacement of the cartilaginous septum from the bony, at their point of junction. The treatment must consist in the accurate readjustment of the displaced parts by intra-nasal and extra-nasal manipulation, and their retention by means of mechanical supports, probably within the nasal passages. If the septum be broken into several pieces, as is sometimes the case, their immediate removal is indicated; and under any circumstances, if reposition cannot be effected, and if the subsequent deformity be sufficient to occasion occlusion, the offending parts may be cut away.

TUMORS OF THE SEPTUM, aside from the *osseous* and *cartilaginous* outgrowths which not infrequently affect it, are rare. The former are the least common, and are only met with far back in the nasal passage, over the bony portion of the septum. They are more or less linear in shape, stretching in an antero-posterior direction, sometimes with a sharp exterior edge, at other times more flattened; upon their size depends the amount of nasal obstruction that they cause, and their true nature may usually be at once appreciated from their density and their location.[1] The cartilaginous outgrowths or thickenings, on the other hand, occur anteriorly in the nasal fossæ, and, for the most part, are attached by broad bases to the septum and adjoining parts of the floor of the nose. Their removal, if indicated, is readily accomplished. I have been in the habit of slicing them off, as it were, from the septum, by means of a long, strong, probe-pointed knife; the incision is easily made; the removal, if the knife is kept parallel to the septum, is thorough, and the result good; the wound of the mucous membrane heals over kindly. When an exostosis or spiculum of bone projects from the side of the vomer, it must be of necessity removed by means of a small chisel, the patient being anæsthetized, or by the small, double gouge-forceps devised by Weir.[2] Goodwillie[3] recommends for the same purpose, the use of the surgical or dental engine, drilling away the bony mass by the revolving multiple-knife inclosed within a sheath. Cohen has reported a case of exostosis from the palatine ridge of the superior maxilla and vomer, occluding the right nostril, which he removed with the burr of the dental engine[4], and Pomeroy[5] gives a similar instance. Of the other forms of tumor, *papilloma* is, perhaps, the most frequently encountered.[6] The growths generally occur just above the orifice of the nostrils, and spring from the mucous membrane of the septum at this point. In five instances that I have met with, the tumors have been small, and always unilateral, and have occurred in young persons, giving rise to some obstruction of the nasal passage, but notably to recurrent attacks of epistaxis. In a sixth case, recently seen, the tumor grew from the anterior extremity of the right inferior turbinated bone; it is the only one that I have ever seen in this locality. The general resemblance of these tumors to papillomata of the mucous membrane of other parts, renders their recognition easy, and as they may be easily and effectually removed by the knife, snare, or scissors, their occurrence is a matter of more interest than importance. *Gelatinous polypi*, true myxomata, are occasionally encountered springing from the side of the septum.

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[1] British Med. Jour., Oct. 2, 1875.

Cohen is authority for the statement that *cystomata* sometimes occur in the same situation. The treatment consists in evacuation of the colloid contents of the sac, by incision, and in local medication of its walls so as to excite adhesive inflammation. Van Vadja[7] has seen a case of *sarcoma* of the nasal septum in a male syphilitic subject, and Mason[8] one of *myeloid* tumor.

CONGENITAL OCCLUSION OF THE POSTERIOR NARES is a rare affection. Its subjects are, as a rule, very young children, and the obstruction to nasal respiration makes itself manifest soon after birth, upon attempts being made to suckle the infant. The attendant symptoms—difficult respiration, frequent suffocative attacks, and mucous discharge—persist, should the child survive, into later years. Several cases are reported in medical literature. In Emmert's[9] patient, a boy of seven, the nose was well formed, but the choanæ were closed by a bony wall. He had never breathed through the nose, and had been nourished as an infant only with the greatest difficulty. Fraenkel[10] demonstrated in a like case, in a young man, the existence of a smooth and solid bony wall, covered on both sides with mucous membrane, occluding the right naris posteriorly. Cohen[1] does not state the nature of the obstruction in the case of an infant which he successfully treated. Voltolini operated with the galvano-cautery upon a total occlusion of the right posterior naris, due apparently to congenital adhesions, and long mistaken for nasal tumor. Bitot[2] has seen an instance, in a fœtus of seven months, in which the atresia or obturation of the posterior orifices of the nasal passages was due to the presence of two triangular bones, articulating above with the sphenoid, below with the horizontal plates of the palatine bones, to the outside with the lesser wings of the pterygoid processes, and impinging on each other interiorly. An equally reliable and close post-mortem observation has been made by Luschka[3] on the cadaver of a girl who died soon after birth. Here the bony framework was formed by the palatal bones on both sides. The posterior, normally free and concave border of the horizontal plate was continued in a somewhat oblique direction upward and backward, to the lower surface of the body of the sphenoid bone, being attached to the latter by a serrated edge. Laterally, the bony plate reached the inner side of the lamina interna of the pterygoid process. In the median line, the lamella joined its fellow at the point where the posterior nasal spine usually arises, while the two, in their further progress upwards, were separated by a very narrow slit, into which the lower extremity of the rudimentary vomer had penetrated. More recently, instances of congenital occlusion have been reported by Gosselin,[4] Morton,[5] Brandeis,[6] Wilkinson,[7] and Ronaldson,[8] the cause in the last surgeon's case having been a thick, firm membrane. Koch reports a curious case, which may be mentioned here, viz., one of cicatricial closure of the right posterior naris, following a scrofulous pharyngo-laryngitis;[9] and, finally, Mackenzie[10] relates the following case:—

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[1] See Michel, Gaz. Hebdom., 1873.

[2] Medical Record, March 13, 1880.

[3] New York Medical Gazette, July 31, 1880.

[4] Medical and Surgical Reporter, July 13, 1878.

[5] Medical Record, June 11, 1881.

[6] See Féré, Bull. Soc. Anat. de Paris, tome iv. p. 587. 1880; Maiocchi, Gaz. Med. di Roma, t. iv. p. 265. 1878; Delavan, Archives of Laryngology, vol. iii. No. 2.

[7] Wien. med. Presse, 18 Marz, 1877.

[8] Lancet, April 29, 1876.

[9] Lehrbuch der Chirurgie, Bd. ii. S. 355. Stuttgart, 1853.

[10] Ziemssen's Cyclopædia, vol. iv. p. 113.

> The naso-pharynx was separated into two lateral halves by a thin bony partition, continuous anteriorly with the posterior edge of the vomer, and inserted posteriorly into the posterior pharyngeal wall. Superiorly it became fused with the pharyngeal vault. The septum narium was slightly deflected to the left from before backward; the bony lamella had a similar inclination, and seemed to be in fact a backward prolongation of the vomer. Its inferior edge was more or less sharp, clearly defined, and curved from before backwards and upwards, presenting a very marked resemblance to the normal posterior curve of the nasal septum. Its insertion into the pharyngeal wall was on a higher plane than that of its origin, which corresponded with the inferior edge of the septum. Attempts were made to dislocate it, but without success.

The indication for treatment lies in establishing, by surgical means, an opening through the affected nasal passages, at as early a date as possible. In the case of membranoid occlusion, this may easily be accomplished by means of the knife and subsequent use of bougies, to dilate and keep open the artificial perforation. In Cohen's case the occluding structures were bored through with a knife and steel probe, and the passage kept open and enlarged, from time to time, by the insertion of a sound, and subsequently of small bits of sponge fastened to a holder. When the occlusion is of a dense and bony nature, the employment of the burr of the dental-engine, elsewhere alluded to, suggests itself as the best, quickest, and safest means of perforation.

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[1] Diseases of the Throat, p. 385. 1879.

[2] Archives de Tocologie. Sept. 1876.

[3] Der Schlund-kopf, S. 27. Tübingen, 1868.

[4] Gazette Méd. de Paris, No. 36. 1877.

[5] Surgery in the Pennsylvania Hospital, p. 333. Phila., 1880.

[6] London Med. Record, April 15, 1882.

[7] North Carolina Med. Journal, vol. ix. page 305. 1882.

[8] Edinburgh Medical Journal, vol. xxvi. page 1035. 1880–1

[9] Ann. des mal. de l'oreille et du larynx, No. 4, 1878.

[10] Archives of Laryngology, vol. iv. No. 3.

Bifid Septum.—A curious abnormality of the posterior nares, of which I am aware of but two instances, those reported by Schroetter[1] and myself,[2] is as follows: The posterior edge of the septum narium, from its point of mergence into the parts making up the vault of the pharynx to one-half way in its course from the floor of the nares, is divided vertically into two distinct halves, inclosing between them a small space; this space is more or less triangular in shape, its base lying above, and is lined apparently with normal mucous membrane. This description applies to both of the instances mentioned. In neither was there any history of injury or disease; the condition gave rise to no symptoms, and was discovered only by accident, during rhinoscopic examination.

Foreign Bodies in the Nasal Passages.

Articles of the most varied character, form, size, and description, are not infrequently found lodged within the nasal fossæ, either as the result of accident or design; especially is the latter the case in children. Fraenkel, moreover, calls attention to the fact that foreign bodies may originate within the organism, having their source, in such cases, first, within the nose or neighboring cavities—as for instance, in the detachment of necrosed bits of bone—or second, originating elsewhere in the body, carried into the nasal cavities, and lodged there: as examples may be quoted, the entrance of part of the contents of the stomach through the posterior nares into the nostrils, in violent attacks of vomiting, and the occasional presence of the ascaris lumbricoides within these or the contiguous cavities. Thiedemann[3] has collected a number of cases in which the lumbrici, having reached the stomach, passed out of the body by the nose instead of the mouth, or even remained for some time in the former, causing by their presence great local disturbance.

If the foreign body come from without, it has but three points of entrance: first, and most commonly, through the anterior nares; second, but rarely, through the posterior nares; and finally, infrequently, through the soft parts of the face, as is seen in gunshot wounds, accidents of various kinds, stab-wounds, etc.[4] The latter two classes, from their infrequency, need but passing mention. Lowndes[5] reports the case of a ring—too large to have passed in through the anterior nares—as having been lodged in the post-nasal cavity, where its presence could only be accounted for by its having been swallowed and passed into the nose from the lower pharynx; and Noyes has removed the entire breech-pin of an exploded gun from the nasal cavity, where it had long lain undiscovered, the patient having applied to Dr. Noyes for treatment of his eyes.[6] The catalogue of the foreign bodies introduced into the nostril through its anterior opening, forms an interesting and curious, but illimitable list. Buttons and glass beads are favorite articles with children. I have removed carpet-tacks, nuts, small pebbles, copper rivets, bits of wood, pieces of coal, shot, pins, and beans; in the case of the latter, germination is possible, although I have never seen it.

The foreign body once introduced, if discovered by the attendant, or its introduction acknowledged by the patient, is usually quickly removed, if efforts looking towards that end are at once made by the surgeon; on the other hand, if forgotten and undisturbed, it not unfrequently remains *in situ* for years, covered probably with phosphatic deposits, keeping up a constant irritation, muco-purulent discharge, and offensive smell, and not very rarely being mistaken for carious bone, the result of struma or syphilis. Two such instances have come under my observation. In one, the foreign body, a shoe button, thickly covered with calcareous matter, had lain undisturbed for some eighteen years, having been introduced by the patient when a child, a fact distinctly remembered when its presence was demonstrated. In the second, a bean, likewise encrusted, was removed after a sojourn of some fifteen years. In both cases, all the symptoms of fetid catarrh were present. The presence of a foreign body had been demonstrated, and, through the supposition that this was necrosed bone, both patients had been for some time under anti-syphilitic treatment. No attempt at the removal of the foreign body had been made in either instance.

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[1] Laryngologische Mittheilungen. Wien, 1875.

[2] Med. News, Jan. 7, 1882.

[3] Von lebenden Würmen und Insekten in den Geruchs-organen des Menschen. 1844.

[4] Cloquet, Osphrésiologie. Weimar, 1824.

[5] British Medical Journal, September, 1867.

[6] See also Lancet, May 3, 1884.

The *symptoms* caused by the presence of a foreign body within the nose, vary naturally according to the duration of its stay, as well as upon its irritating or non-irritating nature and form. If the latter be sharp, irregular, or pointed in character, considerable inflammatory reaction will follow its entrance into, and impingement upon, the nasal mucous membrane, while a smooth, rounded body, on the contrary, will give rise to little or no local disturbance. As a rule, the symptoms in recent cases are simply those of an ordinary chronic coryza, with abundant purulent discharge, and the results of the occlusion of a nasal passage. Should, however, the foreign body be of such a nature that it imbibes moisture from the nasal walls, and swells within the bony inclosure in which it lies, to these symptoms must be added those due to the pressure and tension that it causes, viz., pain, severe headache, and distortion of the nose. Should its sojourn be one of months or years, all the symptoms of a fetid catarrh will probably be developed, as in the instances above reported; and in cases where the foreign body is sharp and irregular, ulceration of the mucous membrane at its point of lodgment, with bloody discharge at times, and increased pain, will be the rule, and will still further complicate the existing conditions.

The *diagnosis* of a foreign body within the nostril is greatly assisted by the statement of the patient, if this can be obtained; in default of it, it must rest upon the results of inspection and palpation. The foreign body being usually obscured by a thick coating of mucus, a thorough washing out of the affected nostril will be found desirable as a preliminary to the use of the probe Much valuable information may thus be obtained as to its nature, form, and method of lodgment. The probe, carefully used, establishes the fact of its existence. It can be but confounded with one condition, viz., necrosed bone. The mobility of the object, the character of its surface, and the peculiar sensation conveyed to the finger by the probe on touching it, will always serve to differentiate the substances. It is hardly necessary to add, that in default of a clear clinical history of the presence of a foreign body, a careful examination should be instituted in every case of offensive discharge from the nares, attended by symptoms of occlusion, both by anterior inspection and by the use of the rhinoscopic mirror.

The *treatment* of a foreign body within the nares lies in its removal at as early a date as possible after its entrance. To do this will often tax the inventive ingenuity of the surgeon. Small, loose bodies may sometimes be quickly expelled by exciting sneezing in the patient; blowing strongly into the unaffected nostril, is also said to expel the offending substance from the other. King gives an instance of the expulsion of a cherry-stone from the nose during the action of an emetic, the mouth being held closed at the moment of emesis. Success may be obtained by the injection of a powerful stream of water through the nares, either anteriorly, by means of a large syringe held to the unoccluded nostril—the best method—or by the use of the nasal douche, the can being well elevated to render the pressure strong; or the posterior nasal syringe may sometimes succeed in driving out the foreign body, if it be not firmly impacted, by the mere mechanical force of the stream of water. Cohen recommends that curved bougies or probes be passed up behind the velum into the occluded nostril, and the foreign body thus pushed forwards. He also alludes to the method pursued by aurists to remove bodies impacted in the external auditory meatus—by placing a brush, loaded with glue or other adhesive fluid, in contact with it, and allowing it to remain until firmly adherent, so that the brush can be used as a tractor—as applicable in the removal of certain classes of foreign bodies from the nose. When the foreign body is large, and perhaps firmly imbedded in the soft parts, it must be seized directly by means of the fenestrated scoop, slender hook, curved probe, or small, slender forceps, made in two distinct portions which may be introduced separately, one on each side of the foreign body, and afterwards locked together like midwifery forceps.

Some care, and a little attention devoted to the peculiarities of each case that may be treated, will render easy the choice of the special instrument best adapted to the extraction of the foreign body. For instance, I have on a few occasions been able to hook a small probe into the eye of a button firmly fixed in the nostril, and thus readily remove it. The forceps would have but pushed it further into the nasal passage. The latter is a not unfrequent occurrence, which renders subsequent efforts at removal anteriorly even more difficult. Even with care, it is sometimes not to be avoided, and the question arises, when, from its location, size, and impaction, a foreign body cannot by any gentle means be removed through the anterior nares, whether it should not be pushed backwards into the pharynx, either there to be caught and extracted, or, as is commonly the case, to be swallowed and afterwards discharged by the rectum. My own experience is, that when necessary (I do not hold that it is desirable) this may be done with impunity. I have never met with the danger so forcibly alluded to by some writers, viz., that of the foreign body falling into the larynx; nor have I found it necessary to follow their advice and protect the entrance to this organ. The results where I have followed out this plan of treatment, unsurgical I admit, have been favorable. In a case reported by Morrman, a foreign body, lodged far back in the nasal passage, was pushed forwards within reach of the forceps by closing the mouth with the hand, so as to cause the patient to breath alone through the nose. In rare instances, where extraction is impossible by any of the above means, it may be necessary to gain direct access to the point of impaction by means of some form of external excision. The operations that have been employed are: the division of the wing of the nose (Vidal); division in the median line (Dieffenbach); and raising the whole nose by means of an incision through the gingival margin of the upper lip, and thence dissecting upwards (Rouge). Finally, to proceed to the other extreme, Watson alludes to the possibility of leaving the foreign body to be extracted, partly by nature's efforts and partly by the assistance of art. In process of time ulceration will take place around it, and this will have the effect of loosening it from the bed in which it has been so tightly wedged; then, by using the douche apparatus through the opposite nostril, it may be dislodged and expelled.

NASAL CALCULI, OR RHINOLITES.

Calcareous concretions are occasionally encountered in the nasal fossæ, their origin, probably, being always due to hard foreign bodies which have been forced into these passages at dates long antecedent to their discovery, and which have in process of time become nuclei for deposits consisting, according to Demarquay,[1] of phosphates of lime and magnesium, chloride of sodium, and the carbonates of lime, magnesium, and sodium—in other words, essentially the sediments of the saline portion of the serum of the blood. Numerous cases may be found scattered through medical literature, in some of which the calculus has attained an extraordinary size, even that of a pigeon's egg, weighing three or four drachms. Many of the earlier cases are cited by Demarquay, in his elaborate work. Bartholin, quoted by Cloquet,[2] relates the instance of a young woman, who, after suffering a long time from headache, passed from her nose several calculi, which, in size and and shape, resembled date-stones. Clauder witnessed the case of a woman, who expelled from her nose, a very hard, round concretion, as large as a hazel-nut. Khern mentions several pisiform calculi which had escaped from the nostrils of a young person suffering from a violent headache. Riedlin, D'Ulm, Buchner, Plater, Watson, and others, add similar instances. Savialles informs us of a case of the same kind, which had for its nucleus a foreign body introduced into the nose from without. Some remarkable cases are to be found in the Contributions to Pathology and Surgery[3] of Mr. Hawkins. Roe[4] reports an instance occurring in a young woman, in which the rhinolite weighed, after removal, forty grains. Two instances of my own have been alluded to above. Although in all of these cases, as has been stated, some foreign body introduced from without has probably formed the nucleus of the concretion, and although this is the common cause of the formation, Watson[5] holds that it is possible that the crusts formed in fetid catarrh or ozæna, may, when retained for a lengthened period, become consolidated, and subsequently encrusted with the carbonates and phosphates of lime; but he admits that such instances must be rare. Two cases which he records seem to bear out this view.

Nasal calculi may be formed in any of the various passages of the nose; they may even originate in the frontal or maxillary sinuses, and pass thence into the nasal canal, or be formed beneath the pituitary membrane, lying imbedded in the tissues; as a rule, however, they are formed in, and will be found lying in, the inferior meatus of the affected cavity, and their exact position will be determined by the method and direction of their introduction. The reason of their formation is not so clear. Gräfe argues in favor of a gouty dyscrasia, as favoring their production. Durham, with more probability, holds that chronic inflammation of the nasal fossa and lachrymal gland, may give rise to such alterations in the secretions that, a foreign body being present, the deposition of calcareous matter around it can readily be explained. Such deposition is also favored by various anatomical abnormalities, preventing the free exit of secretions. Brown[6] reports such an example, in which cicatricial closure of the nostril, following smallpox, gave rise to the formation of a calculus weighing three and one-half drachms, which was removed by incising the occluding membrane.

After what has been said, it can readily be understood that nasal calculi may constantly increase in size through the deposition of successive layers, that their contour must depend upon the shape of the cavity in which they are formed, and that they may be either hard and firm, or soft and friable, in their nature. The symptoms to which they give rise have in great measure been detailed in speaking of other causes of nasal obstruction, and of foreign bodies. Pain is a more constant symptom, however; and periodical hemicrania, terminating by the evacuation of a nasal calculus, has more than once been reported.[1] An ichorous or muco-purulent discharge—sometimes stained with blood, and of an offensive character—is never wanting. The very character of this discharge may lead to the mistaken diagnosis of ozæna, or fetid catarrh, especially in those cases of calculi in which the mass is encysted beneath the mucous membrane, or located so far posteriorly that it cannot be seen. The peculiar, characteristic click of the probe against it will, in the latter instance, however, render the matter clear. The dilatation of the nostril and the obstruction to respiration will still further complicate the differential diagnosis between calculus and nasal polypus;[2] and the deformity and accompanying suppuration, that between the same condition and necrosis of the nasal bones; but with care, direct inspection, and thorough probing, the difficulty is easily overcome. The latter is the mistake commonly made; instances are probably familiar to many of us. In a reported case, the calculus was a large one, and was removed by lithotrity in four sittings; it had been mistaken for necrosis of the malar bone. Fraenkel, finally, calls attention to the danger of confounding nasal calculi with calcareous degeneration of the mucous membrane itself. The latter is sometimes found in the nose, especially in the old, but occasionally likewise in the young, in consequence of the ossific diathesis; the membrane covering the turbinated bones may develop, first, fine granular points, and afterwards, plates of calcareous matter. The condition is, however, a rare one. The diagnosis having been made, the removal of the calculus may be at once undertaken by the same methods as were detailed in treating of the removal of foreign bodies from the nasal passages. Granted that it be not too large, nor too firmly imbedded, and that it is accessible, the scoop or forceps will be all-efficient means of removal. In cases where the rhinolite is located beneath the mucous membrane, it will be necessary to incise this down to the stone, to allow of its extraction. Erichsen[3] mentions two cases of this kind as occurring in children. When the calculus is too large to permit of extraction by the natural nasal opening, it must of necessity, in order to lessen the danger of laceration of the soft tissues, be crushed up by a strong pair of forceps, or drilled through, and the *débris* washed out by the syringe introduced into the unaffected passage. Cohen recommends that in some instances the point of a knife should be passed under the edge of the calculus, a short distance into the soft parts, and that it should then be pried out, in part, by some blunt instrument. The subsequent treatment, after the removal of the concretion, will be the thorough cleansing of the nasal cavities, and the application of such astringent remedies as may tend to allay inflammation, reduce inflammatory thickening, and heal superficial ulceration. These results—with a subsidence of all subjective and objective symptoms—usually follow very quickly the removal of the offending body.

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[1] Mémoire sur les Calcules nasaux. Arch. Gén. de Méd. 1845.

[2] Op. cit.

[3] Vol. i. p. 225.

[4] Archives of Laryngology, vol. i. p. 149.

[5] Diseases of the Nose.

[6] Edinburgh Med. Jour., vol. v. p. 50.

Parasites of the Nasal Cavity.

The entrance of living creatures into the nasal cavities is always more or less a matter of chance, and the occurrence a rare one, although the older writers, manifestly wrong, ascribed all cases of ozæna attended with severe frontal headache to the presence of insects or their larvæ in that situation. Numerous cases are not wanting, however, in modern times, in which the diagnosis has been established by ocular demonstration, and the possibility of the occurrence thus shown. Thiedemann[1] has collected proof of the existence within the nose of centipedes (Scolopendræ), ear-wigs (Forficula auricularia), and the larvæ of the bacon-beetle (Dermestes lardarius). The occasional presence of the Ascaris lumbricoides has already been alluded to. Urbanck reports such an instance;[2] Packard, one of the accidental entrance of a centipede into the nostril;[3] and Buchanan, a case of the deposition of the ova of the fly in the nasal fossæ.[4] Leeches have been known to effect an entrance, and to have been dislodged with great difficulty, from these cavities. The larvæ of the dipterous insects, also, are of even more frequent occurrence. Coquerel[5] reports five cases in which these larvæ, lodged in the frontal sinuses and nasal passages, produced violent symptoms, which in three of the cases were followed by death. In most of them, several hundred larvæ were evacuated by ulceration and necrosis of parts investing the cavities. Coquerel also quotes in his article several analogous cases from authors who had observed similar occurrences in Europe. Cloquet[6] reports a somewhat similar case. An excellent summary of our present information on the subject is given by Fraenkel. Attracted by the odor emanating from an ozæna, flies are found (Musca vomitoria and Musca carnaria) which deposit their eggs in the vicinity of the nostrils, the young being nourished, when hatched, by the decomposing organic matters. Maggots likewise are occasionally seen in cases of ozæna, as in any other purulent and fetid surface or cavity of the human body. According to Von Frantzius, this occurrence is a frequent one in the tropics.[7] Weber[8] tells us that in the same locality, especially in Cayenne and Mexico, there is a fly (Lucilia hominivora) which sometimes forces its way even into healthy noses and lays its eggs there; the larvæ, measuring one-half inch in length, are developed at the end of fourteen days. Finally, the larvæ of the gad-fly (Oestrus) are rarely found in the human nose.

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[1] Axmann, Arch. Gén. de Méd., Mai, 1829.

[2] Voltolini narrates the history of such a case. Die Anwendung der Galvano-kaustik, S. 240. Zweite Auflage. 1872.

[3] Science and Art of Surgery, vol. ii. p. 390.

It has been stated that centipedes may remain for years in the frontal sinus. Other parasites make of necessity but a temporary sojourn in the nose. Upon the duration of their stay, then, will depend in great measure the intensity and seriousness of the symptoms. These are never unimportant, and the attendant pain and distress, amounting in many instances to agony, leading to psychical disturbance, delirium, and even death, are graphically described by several authors. All the evidences of general as well as local inflammation, with high fever, are present; the face and fauces become swollen; the nasal discharge becomes fetid and bloody; and ulceration and perforation, especially of the palate, may occur. The prognosis of such cases must always, then, be a guarded one, and frequently unfavorable.

Treatment, if we may judge from the reported instances, is not always attended with success. If the parasites be large and easily reached, they may be extracted with forceps; if they are numerous, careful syringing with carbolized solutions, or, as has been recommended, with solutions of corrosive sublimate, with decoctions of bitter herbs or tobacco, or with turpentine, may succeed in dislodging them. The inhalation of chloroform has been highly spoken of as an efficient means of accomplishing the latter result.

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[1] Op. cit., S. 11.

[2] Wiener med. Presse, No. 7, 1878.

[3] Med. and Surg. Rep., Aug. 3, 1878.

[4] Phila. Med. Times, Oct. 30, 1876.

[5] Arch. Gén. de Méd., Maì, 1858.

[6] Am. Jour. Med. Sci., May, 1828.

[7] Virchow's Archiv, Bd. xliii. S. 98.

[8] Recherches sur la Mouche Anthropage du Méxique. Rec. de Mém. de Méd. etc. Mil., Fév. 1867, p. 158.

TUMORS OF THE NOSE.

EXTERNAL TUMORS.—Tumors located *externally* upon the nasal organ, are of very rare occurrence, and among them the *sebaceous* growth hardly deserves the name of tumor. It is usually small, painless, and of slow growth, and its soft, compressible consistence serves to readily distinguish it from other varieties of neoplasm. Once extirpated, it does not recur. The *fibroid* tumor generally springs from the surface of the fibro-cartilage of the nose lying immediately below the perichondrium, and exhibits the same structure as similar growths in other parts of the body. (Gross.) An important fact in connection with it is its tendency to recurrence after removal. *Lipomatous* tumors, the only other variety of growth met with externally, consist of an accumulation of the subcutaneous adipose tissue, usually associated with marked hypertrophy of the overlying integument, and increased vascularity with distension of the sebaceous crypts. Lipoma occurs in elderly subjects, and is easily recognizable by its lobulated appearance, pendulous character, and soft consistency. The remedy for the disease lies in its excision, care being taken to preserve the nasal cartilages intact.

TUMORS OF THE NASAL PASSAGES.—Tumors of varied pathological nature affect the nasal passages, arising either primarily within them, or involving them secondarily by a process of gradual extension from the neighboring and communicating sinuses and cavities. The commonest form is unquestionably the *mucous* or *gelatinoid polypus*, while the more serious, such as the *fibrous* or *naso-pharyngeal polypus*, the *osseous* or *cartilaginous* growths, as well as the semi-malignant *sarcoma* and malignant *carcinoma*, are fortunately rare. Other forms of tumor are but infrequently seen, and need but passing consideration; they are the *adenoma*, *papilloma*, *neuroma*, and finally *cystic* growths.

General Symptoms.—The earliest symptoms, due to the presence of any tumor within the nasal passage, being in all cases nearly identical—certainly in the incipient stages of its formation—and, as Mackenzie remarks, being neither distinctive with respect to the different classes of growth, nor, in fact, distinguishable subjectively from those of chronic rhinitis, it may be well to consider them here collectively, laying special stress upon those of a later date which in certain forms of neoplasm have a diagnostic significance. Hypersecretion, sensation of fulness, and constant desire to clear the nose and throat, with perhaps frontal headache and some nasal obstruction to respiration—in short, the symptoms of a chronic coryza—are the first to attract the patient's attention, and become so gradually pronounced that the surgeon's attention is rarely called to the affection in this stage. As the tumor develops, however, all the symptoms and attendant discomfort, due mainly to obstruction of one or both nasal passages, are decided. The patient then breathes partially, perhaps wholly, through the open mouth, the senses of taste and smell become blunted, and the voice acquires the characteristic, nasal intonation. The direction of the growth of the tumor determines the development of further conditions: if it be backwards, it presses upon the pharyngeal orifice of the Eustachian tube, and impairment of hearing follows; if upwards and forwards, it presses upon the outlet of the nasal duct, and lachrymal abscess, epiphora, or mucocele of the lachrymal sac are not unusual results; if backwards and downwards, it encroaches upon the soft palate, and limits its movements in deglutition; and finally, by blocking up the outlet of the antrum of Highmore, it may induce the development there of a cystic or other growth. Mucous polypi being often pedunculated, give rise to an uneasy sensation by moving backwards and forwards in the respiratory current through the nose; and, being likewise hygroscopic, or ready absorbents of moisture, their size, and the consequent degree of occlusion which they cause, vary greatly with changing atmospheric conditions. Even when they are multiple, or their size excessive, they rarely cause any distortion of the neighboring parts, the soft growth or growths adapting themselves to the contour of the surrounding nasal walls. The fibroid growth, on the contrary, displaces all in its growth, pushes aside the septum, absorbs bone or separates connecting sutures, and penetrates and develops in all directions, producing the characteristic deformity known as "frog face" when it invades and displaces the antrum on either side; in the latter case the attendant nasal discharge, usually of a thin, watery nature only, becomes purulent and even fetid, and frequent attacks of epistaxis occur.

Pain is a frequent symptom in this class of growth likewise, as well as in the osseous, cartilaginous, and malignant varieties, and may be excessive. Not only does characteristic deformity of the nose attend all of these forms, but displacement of the eyes, strabismus, inability to close the lids, chemosis, conjunctivitis, distortions of the internal parts of the mouth, and the like, are no unusual results. With sarcoma and carcinoma must be added, softening and ulceration of the tumor, with their sequelæ, fungoid granulations, hemorrhages and fetid discharges. Constitutional cachexia and infiltration of the neighboring lymphatics, are absent in sarcoma, present in carcinoma; with both there is excessive pain, and a tendency to penetrate into the cavity of the orbit or brain, or destroy in their onward march the tissues and soft parts of the nose and cheeks, and appear externally upon the face as a fungoid, bleeding mass.

One complication or result of the nasal obstruction caused by polypi, or even by the hypertrophy of the tissue over the turbinated bones, in certain instances, is of sufficient interest to demand special mention. I allude to their direct influence in the causation of *bronchial asthma*. Thudichum[1] asserts that there is no more common complication of nasal diseases, particularly polypus; and since the first observation was put upon record by Voltolini,[2] numerous cases have been detailed, and the subject carefully studied by several authors—Porter,[3] Fraenkel,[4] Haensisch,[5] Daly,[6] Hartmann, Spenser, Rumbold, Todd, Mullhall, and Schäffer. Joal[7] details eleven cases of his own, in all of which the asthmatic attacks immediately disappeared after the removal of the polypus, though in some instances only to return as soon as the nasal respiration became affected by the recurrence of the growth. All of the patients were of marked gouty constitution. He shows us that mucous polypi, which may be innocent in some individuals, in others play a part—occasional, without doubt, but powerful—in the causation of nervous respiratory troubles. All of the above observations show then, beyond question, that not only may the reflected irritation from nasal obstruction be the exciting cause of asthma, but that, if the cause be prolonged, local bronchial lesions may be the result (Thudichum); and that to cure the condition, the removal of the cause of the reflex irritation is requisite, and usually promptly succeeds. The irritation of the pneumogastric nerve, which induces the spasmodic contraction of the bronchial muscles, and thus approximates the cartilaginous rings of the bronchi (Bert, Traube), is probably excited by reflected impressions received through the medium of the fifth nerve. (Other less tenable theories, it may be here stated, are advanced.) It has been objected that this implies peripheral irritation producing central disturbance, thence reflected to the nerve of supply and to the part affected—that is, an impression conveyed from the origin of the fifth nerve to the origin of the pneumogastric. But Porter remarks, that even were this true it would not disprove the theory; and he adds, that there is a more direct line of communication. The pneumogastric, though in its origin a sensory nerve, receives motor filaments from the seventh, or portio dura (to auricular branch), from the spinal accessory (to ganglion of the root), from the hypoglossal (to ganglion of the trunk), and from the first and second cervical nerves. As the contiguity of the origin of the cranial nerves is now demonstrated, it is reasonable to suppose that impressions may be conveyed from the origin of the fifth nerve directly to the origin of any of these, and thence by a continuous motor-tract to the pneumogastric.

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[1] Lancet, April 17, 1880.

[2] Galvanokaustik, S. 246, 312. 1871.

[3] Med. Record, Oct. 11, 1879, and Archives of Laryngology, vol. iii. No. 2.

[4] Berlin klin. Wochenschr., Nos. 16, 17. 1881; and Ziemssen's Cyclopædia, vol. iv. p. 107.

[5] Berlin klin. Wochenschr., S. 503. 1874.

[6] Archives of Laryngology, vol. ii. 1880.

[7] Archives Gén. de Médecine, tome i. 1882.

The original and direct cause of the irritation does not arise in the polypus itself, in cases where it is present; this is impossible, as the ordinary gelatinous polypi are destitute of nerves, and can therefore, as J. N. Mackenzie justly observes,[1] only awaken reflex phenomena in an indirect or mechanical manner. They do so then only when they spring from, or, much more commonly, by their position, form, etc., are brought in contact with, the erectile tissue covering the inferior turbinated bones, and especially their posterior extremities. By acting here as a mechanical irritant, they cause engorgement of the mucous membrane and erectile cells, and thereby excite the chain of reflex action described above.

Aside from asthma, *reflex cough* has recently been recognized as a symptom of a number of pathological conditions, affecting especially the erectile tissue covering the posterior extremities of the turbinated bones, but J. N. Mackenzie[2] has called attention to the direct influence of nasal polypi in its production. The cough is only present, he tells us, when the growths are brought in contact with the erectile area alluded to above, and thus excite reflex action and produce explosive cough. The probability of cough excitation will mainly depend therefore, other things being equal, upon the position of the growth. In regard to the mechanism of the reflex, two explanations are given: either the assumption of the correlation of the nasal erectile area and the inter-arytenoid space (laryngeal cough centre), by virtue of which irritation and vascular engorgement of the former may lead to hyperæmia of the latter through the medium of the vaso-dilator nerves, through the superior cervical ganglion, and to the consequent production of a laryngeal cough; or the direct transmission of the irritation through the spheno-palatine nerves to the medulla, and its immediate reflection outwards to the muscles concerned in the expiratory act.[3]

As has been said, the removal of the polypus, or other occluding cause, from the nasal passage, has, in the majority of instances reported, been effectual in curing the asthmatic complications and the cough, without recourse being had to further measures. It is advisable that this should be done at an early date, to prevent any possible change in the texture of the lung tissue, or the occurrence of chronic hyperæmia.

General Diagnosis.—By means of a skilful anterior and posterior rhinoscopic examination, the observer is almost always in a position not only to diagnosticate accurately the fact of the presence of a growth within the nasal passage, but likewise to determine its location, extent, and not unfrequently the nature of its attachment, and, from its appearances alone, its pathological nature; exceptions exist, it is true, especially in the case of multiple growths, and those of great size, which involve neighboring cavities; here much care and repeated examinations are necessary to establish a correct diagnosis. Certain facts, if borne in mind, will serve to elucidate the problem, and these are so clearly stated in the valuable essay of Mackenzie,[1] that I here take the liberty of presenting them in part, in a condensed form, and with certain additions.

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[1] Medical Record, May 3, 1884.

[2] Loc. cit.

[3] See section on Nasal Cough, p. 438.

The softness, elasticity, mobility, and pale translucent appearance of mucous polypi contrast strongly with the hardness, opacity, fixedness, and deeper red color of other tumors. Fibroid, sarcomatous and malignant formations usually bleed, even when gently touched. Cartilaginous and osseous growths are heavy and dense, and offer such a sense of resistance to the probe that their real nature is at once apparent. The probe will also enable the surgeon to distinguish the chronic thickening of the mucous membrane covering the inferior turbinated bone, met with in hypertrophic nasal catarrh, from polypus. In the former case, the absence of a pedicle, the consistence, and the gradual blending of the outgrowth with the structures around the base, assist the differential diagnosis. The possibility of the existence of a deflected septum, and of the blood tumors and abscess of the latter, elsewhere described, must not be forgotten, as they are perhaps calculated to deceive the inexperienced observer. Mucous distension of the ethmoidal cells is mentioned likewise by Watson[2] as a possible source of diagnostic error. Fibromata may be distinguished from mucous polypi, not only by the characteristics of both, mentioned above, but also by their lack of the hygrometric quality. They are generally harder, slower in growth, and more distinctly pedunculated than sarcomatous and cancerous growths. The absence of cachexia, and of involvement of the lymphatic glands, serves also to differentiate them from the last. Cartilaginous growths are never pedunculated, seldom ulcerated, and present more smoothness of surface, with symmetrical, globular outline, than other forms of tumor. The touch alone is sufficient to establish the nature of an osseous tumor; while sarcoma can only be confounded with carcinoma. Mackenzie says that in the nose it is much more frequent than the latter, and can generally be recognized by its occurring at an earlier age, and by its displaying a much milder type of malignancy. Finally, in regard to cancer—for the other growths alluded to as occurring in the nose, but not here mentioned, occur so very rarely that, practically, they are of but little importance in relation to differential diagnosis—there is, unfortunately, no room for doubt when the disease has once commenced to progress; its rapid growth and equally rapid ulceration, and the widespread destruction which it causes, tell the true story of the distinctive malignancy of this form of neoplasm.

Mucous Polypus or Myxoma.—The gelatinoid or mucous polypus is by far the most frequent variety of tumor encountered in the nasal passages, occurring more frequently than all of the other forms combined. Views as to its causation vary. An enlargement of the acinous glands, with attendant hypertrophy of the submucous tissues and covering mucous membrane, with serous infiltration, so that the membrane is pushed or drawn out by the gradual increase of the growth into a narrow pedicle, and this as the result of repeated inflammatory attacks, or chronic nasal catarrh, is probably the common cause; in other words, it may be regarded as a localized hypertrophy. An adenomatous variety is not unusual. Gruner and Pott attribute the origin of mucous polypi to such influences as heredity, struma, syphilis, miasma, suppressed menstruation, and the like (Mackenzie), while instances exist in which the local irritation of a foreign body has determined their development. The polypus, of a dingy, bluish-white color, with a smooth, shining, elastic surface covered by ciliated epithelium, devoid of sensibility and breaking easily under pressure, almost bloodless, of variable size and configuration[1]—the latter being determined by the gravitation of the contents of the polypus downwards, and by the shape of the nasal fossæ—is single or multiple, and attached, as a rule, to the superior turbinated bone, more rarely to the middle, and only very occasionally to the septum;[2] it may spring from the roof of the nose, or may extend into that organ from the frontal or ethmoidal cells, though this occurs but rarely. A single polypus may even be attached at several points to the surrounding nasal parts,[3] but such roots are always to be regarded as the result, in the first instance, of pressure and friction, with subsequent ulceration and cicatricial adhesion, and not as true points of origin. Occasionally polypi contain fibro-cartilaginous concretions, or have small osseous formations upon their surface. Polypi are more frequent in adults than in children, and are found rather in males than in females. Once carefully removed, close to their attachment, the prognosis as regards their re-formation is favorable. Mackenzie[4] says that only one in seven recurs, but he calls attention also to the important fact that, as in the case of recurrent growths, there is always a possibility of malignancy, proportionate to the rapidity with which they increase in size. The prognosis must be a guarded one, until lapse of time has established facts in respect to the question of recurrence or non-recurrence.

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[1] Lectures on Diseases of the Nose. Lancet, July 28, Aug. 25, Nov. 10, 1877.

[2] Diseases of the Nose, p. 72. London, 1875.

Treatment.—The surgeon called upon to undertake the removal of nasal polypi has a wide choice as to means. The inventive ingenuity of the profession has for years expended itself upon this subject, if I may judge from its literature. But here, as in other like conditions, the simplest surgical means consistent with the indications have proved the best. *The application of various drugs* has been, and is to-day, extolled by observers whose ranks from time to time receive additions. Unquestionably, a gelatinoid polypus is occasionally amenable to local remedies, but cures thus obtained are not the rule; these means may be summarized as follows: Primus,[5] the repeated local application of saffronized tincture of opium (Pr. Phar.); Bryant,[6] that of iodine; Mackenzie,[7] perchloride of iron, mixed with sufficient water to form a thick paste (also Reeder); other authorities, oxysulphate of antimony with sugar, gallic acid, tannin alone or in combination with burnt alum, borax, sugar, or camphor (Cohen), alcohol, strong astringent solutions, sulphate or chloride of zinc (Erichsen), or copper, and the like, lime-water, calomel, bichromate of potassium, nitrate of silver (Nélaton), and pulverized blood-root (Gross) as a snuff.

Injections.—Reynolds[8] and others recommend the injection of the polypus by means of a hypodermic syringe with various solutions; among the remedies used, carbolic acid, glacial acetic acid, Lugol's solution, and tincture of the chloride of iron (Reeder), occupy a prominent place.

Evulsion is probably the method most widely employed, and, though condemned in unmeasured terms by Voltolini, Michel, and Zaufal, when forceps are used, in good surgical hands, they can be productive of no harm, not even excessive hemorrhage. In simplicity and certainty this method surpasses all others, and though it is more painful, it is much more rapid. The operation is performed either with forceps, or with some one of the various forms of wire *écraseur*. The *forceps* should be a lightly made instrument, either straight or with a slight curve in its shank, so that the handles will not obstruct the operator's view, and with a firm, close bite, and well-serrated blades. The nostril having been well dilated by means of a nasal speculum—Fraenkel's or any of the ordinary wire specula will answer the purpose—and the polypus, the precise location and attachments of which should have been previously well studied, brought into view, its pedicle or base may be seized, well twisted, and the growth then torn out. When the growth is located far back in the nasal passage, so that it cannot be seen during the introduction of the forceps, the operator must rely in great measure upon his *tactus eruditus*, in his efforts to seize it. Occasionally, a tumor thus located can be pushed forwards into view by the finger carried up behind the soft palate. When the growth is very large and has numerous attachments, it is ordinarily extracted piecemeal. Stoker has invented a forceps for carrying out evulsion very perfectly. A fine forceps is fixed to a wooden handle at an angle of 45°. The growth being seized at its base, the horizontal portion of the instrument is retracted from the groove in which it lies, and is then rotated, while the handle remains firm. The forceps on the pattern of the midwifery forceps occasionally answers a better purpose than the above instruments; one blade at a time is adjusted in position, then both are locked, and a firm hold on the tumor is thus obtained. (Schreger, Richter.) Dzondi recommends that the growth be drawn forwards with one pair of forceps to put its pedicle upon the stretch, and that the latter should then be caught by a second forceps, and crushed through, as close as possible to its attachment. It is possible that, when the exceedingly friable nature of the gelatinoid polypus, and the readiness with which it tears into bits in the grasp of the forceps, render its extirpation difficult, this procedure may be of benefit. A polypus frequently breaks up, and a firm hold upon it, and thorough eradication, root and branch, are impossible, with one introduction of the forceps; in such cases a repetition of the procedure should be undertaken, the blood being syringed away, and frequent halts being made for visual inspection, until the operator is assured that the result for which his operation was undertaken, viz., entire extirpation of the polypus or of the polypi, has been thoroughly accomplished.

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[1] Billroth, Ueber den Bau der Schleimpolypen. Berlin, 1855.

[2] Davies Colley, Brit. Med. Jour., June 30, 1877, p. 810.

[3] Meckel, Path. Anat., pp. 304, 311, 313.

[4] Lectures on Diseases of the Nose. Lancet, July 28, Aug. 25, Nov. 10, 1877.

[5] Am. Jour. Med. Sci., vol. ii. p. 219.

[6] Lancet, Feb. 23 and Aug. 24, 1867.

[7] Lancet, July 28, 1877.

[8] Med. Record, Oct. 1, 1881.

The tendency to the reproduction of these tumors may, to a certain extent, be controlled by the topical use of astringents and even caustics; but upon each reappearance, a repetition of the above procedures, or some one of them, becomes necessary. A case is cited, in the literature of this subject, of an individual who was obliged to submit to an operation of this kind every month for forty consecutive years. In cases where this tendency to reproduction of the polypus exists to an excessive degree, Gross recommends that half or even more of the implicated turbinated bone shall be removed by the forceps, in addition to the polypus, following in this advice the example of Fergusson and Pirogoff.[1] Mackenzie even asserts that there are some polypi which, from their anatomical situation, cannot be removed unless a portion of the turbinated bone be previously taken away, or unless the bone be removed with the growth; and to do this he recommends that an instrument be used which consists of a fine hollow forceps, having toothed edges on one side and smooth edges on the other, while between the two a sharp cutting blade can be rammed down.

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[1] Klin. Chir., Heft iii. S. 74. Leipzig, 1854.

Evulsion by means of the wire-snare is preferred to other methods by many operators, who, through practice, have become expeditious and skilful in applying the wire over the polypus, and pressing it up well towards its attachment—sometimes a small, blunt fork, passed into the nostril, assists this step of the procedure—and it is claimed by many that the method is less painful and more thorough, and that there is less hemorrhage and danger of laceration, than if the forceps is used. (Durham.) Among the many different forms of wire-snare, or *écraseur*, that of Hilton, modified by Blake, and the snare of Jarvis, are perhaps the best. The wire is passed about the growth, and as near as possible about its pedicle, and then drawn home, by sliding back with the fingers the cross-piece on the bar of the instrument to which the ends of the wire are attached. Thus securely fastened about the tumor, this is torn away by withdrawing the instrument from the nose. This procedure answers for growths situated anteriorly, and easily accessible; but when they are located far back in the nasal passage, and, perhaps, hanging into the cavity of the pharynx, they must be encircled by a loop of wire passed through the nose into the mouth, the tumor being controlled by a strong thread previously passed through it, if possible, and coming out of the mouth. The loop of wire having reached into the pharynx, or around the velum into the mouth, is guided over the growth by the fingers of the operator, passed behind the soft palate. A double canula is now sometimes passed over the ends of the wire, through the nose, and the latter is then drawn home so as to strangulate and thus cut away the growth. I can see no object in prolonging this process of strangulation through several days, until the growth drops off from its attachment, as is sometimes done. Bellocq's canula is sometimes of assistance in passing the wire about the polypus in the above procedure, as well as the tying forwards of the soft palate, as recommended by Wales, by means of tapes or elastic cords passed through the nose, brought out through the mouth, and fastened over the upper lip. Much space is thus gained in the pharynx, in which to carry out the requisite manipulations. Much depends, however, in any instance, upon the skill and ingenuity of the operator, and the particular methods of attaining success must be suited to the indications presented by each individual case. Gross succeeded in one instance in breaking off a polypus hanging down into the fauces, by simply introducing the index finger into the mouth, and carrying it around the soft palate; and it is true that polypi may occasionally be removed by the fingers alone—one being thrust into and through the posterior naris, the other through the anterior, and the growth, grasped between them, being pushed backwards and forwards until its attachment is torn through. (Morand and Sabatier.) McRuer, reviving the procedure recommended by Hippocrates, passed a piece of catgut through the affected nostril, and, after it had reached into the pharynx, tied a piece of sponge to it; the latter was then forcibly drawn through the nose, tearing away in its course the adventitious growths. This method, or a modification of it, has recently been advocated also by Voltolini.[1] In any case, care must be taken to secure the tumor previous to its division from its attachment, to prevent its falling upon, or into, the larynx. Knives and scissors are rarely used to excise polypi, unless these be situated in the anterior nares, and thus easily accessible. The toothed scissors of Richardson would here play a useful part. Anæsthetics may be required in any of the above operations, but are a decided disadvantage, and their use should be avoided if possible, and the intelligent co-operation of the patient thus secured. Tamponing the posterior nares, on account of hemorrhage, will be rarely requisite.

The *galvano-cautery*, which was first used in the removal of polypi by

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[1] Monatsschr. für Ohrenheilk., No. 1. 1882.

Middledorpf, and subsequently warmly advocated by Voltolini, is applied either by means of the wire loop, or with various electrodes. In the former case, a platinum wire is passed about the growth, as above described, drawn home through a double tube introduced through the nose, and attached to a suitable handle, which is in connection with a powerful galvanic battery. As soon as constriction of the mass is effected, the connection is closed, and the growth burnt through. The disadvantage of this operation, aside from the pain, is, that the wire can rarely be accurately adjusted to the pedicle of the tumor, and that, as no traction upon the roots is made, the growth is not thoroughly extirpated. Thudichum[1] is at present the warmest advocate of this instrument, but even in one of his own cases the operation had to be repeated some fifty-five times.

Enlargement of the Outlets of the Nasal Cavity.—Such an operation may, in rare instances, be requisite when the tumor is of such a size, or so placed, as not to be easily reached and extracted through the natural openings. The simplest method consists in the dilatation of the nostril by laminaria tents, as proposed by Thudichum, or by the blades of strong forceps. Should, however, more room be necessary, the choice lies between the method of Dieffenbach,[2] by cutting the wing of the nostril to the edge of the nasal bone—or, if both alæ are freed, the septum is also divided, and the nose turned upwards upon the face—or that of Maune (modified by Maisonneuve by leaving the uvula intact, and called the "buttonhole" opening), by incising the soft palate throughout its whole extent in the median line. The latter method is specially applicable to those cases in which the growth is located well back in the nasal passage; the polypus is encircled by the wire loop passed through the opening thus made, and is removed by crushing.

After any of the above operations, careful cleanliness of the affected nasal passage must be insisted upon; and Durham asserts that, in some cases, the insufflation of tannin or other astringent powder is of great service, either in retarding the re-development of the growth, or in aiding the destruction of such portions as may have had their vitality impaired by the operation.

Fibrous Polypus.—This may occur at any period of life. Gross has seen it in children under fourteen years of age, as well as in adults and in old persons; but, originating in the nasal cavity, such a growth is very rare. It may grow from any part of the walls of the nasal fossæ, springing from the aponeurotic covering of the bones, or from the periosteum, with which, as well as with the subjacent bone, it is closely connected; but it is ordinarily attached by a broad base to the superior turbinated bone, or to the roof of the nose, and so far back that it is not readily seen in an anterior examination of the nasal passage. Rogers[3] removed such a polypus from the vomer. Other cases are reported where the growths sprang from the floor of the nasal fossæ, and even from the external lateral walls of the nose; furthermore, they may originate in the antrum, and extend thence into the nose. The exact point of origin is often very difficult to determine, owing to the tendency of the growth to acquire secondary attachments.

Its substance is made up of hard, white fibres, or connective tissue, interspersed richly with bloodvessels; occasionally, round and fusiform cells are present, but rarely in large numbers; its color is a dark red or purple. The surface of the tumor, when denuded of its epithelium, bleeds readily on slight irritation, and is not infrequently ulcerated at several points. Calcareous deposits[1] sometimes occur within it, and cartilaginous and osseous degenerations[2] of the growth are not unknown. Allowed to pursue its course, unrelieved by operation, it often attains an enormous size, and displaces, distorts, and destroys all parts in its immediate neighborhood, giving rise to the most hideous deformity, and to imminent danger from compression of the brain or other cerebral complication.

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[1] On Polypus of the Nose and Ozæna. London, 1869.

[2] Surgical Observations on the Restoration of the Nose and the Removal of Polypi. London, 1833.

[3] N. Y. Jour. Med., vol. i. p. 323. 1851.

A tumor possessing the same general characteristics, and of the same nature, springs usually from the basilar process of the occipital bone and the adjacent part of the body of the sphenoid, and is more common than the first-mentioned form. It is distinguished by its origin, rapid growth, and serious results, and is known as the *naso-pharyngeal* polypus.

Naso-pharyngeal polypus,[3] aside from a point of origin as above, may arise from the pterygo-maxillary fossa; as it enlarges it may extend thence outwards into the zygomatic and temporal fossæ, and inwards through the spheno-palatine foramen into the pharynx; but Sands[4] correctly remarks that tumors thus arising form a special group, and should be distinguished both anatomically and clinically from that which has been mentioned above, which embraces the fibrous growths most often met with in this neighborhood, and to which the name of naso-pharyngeal polypus has been correctly applied. The latter, according to some writers, always springs from the site first given above, but cases exist where it has been found to have had its point of attachment to the following parts: the antrum, the upper part of the pterygoid fossa, the internal pterygoid plate, the greater wing of the sphenoid, the apex of the petrous portion of the temporal bone, and lastly, the edges of the posterior nares; occasionally it springs apparently from the upper part of the spinal column. (Michaux, Robert, and others.) Whatever its site, the tumor extends, in its gradual growth, downwards, or forwards, until it blocks up the entire upper and middle pharynx, involves both the mouth and nasal passages, and, after having displaced or caused the absorption, perforation, or destruction, of all parts opposed to its irresistible onward march, appears at the anterior nares with great distortion of the external nose, or in the middle pharynx with protrusion forwards of the soft palate. Massé records instances in which naso-pharyngeal polypi penetrated the pterygo-maxillary fissure, and passed through the pterygoidean space, between the muscles, towards the face. Extensions are not infrequently found into the antrum, and the frontal and sphenoidal sinuses, and prolongations reach through the spheno-maxillary fissure into the orbit, and displace the eyeball.[5] Robert asserts that these growths spring from the foramen lacerum anterius. The polypi are usually pedunculated, and not infrequently form firm attachments to the various points upon which they press, thus rendering their exact point of origin doubtful. Their growth is rapid, and extirpation is apt to be followed by recurrence. Spontaneous cure by sloughing rarely occurs. (Johnson, Birkett, Bonnet, Vincent, and others.) A marked tendency to undergo sarcomatous degeneration is exhibited,[6] and a special tendency to penetrate the cavity of the orbit, or that of the cranium, although, according to some authorities, the latter occurrence is a rare one. Gross[1] states that these tumors are by far most common in young subjects, between the fifteenth and twenty-fifth years, and that neither his own experience nor recorded instances present any example in the female. To this latter statement, I must except that Marjolin[2] reports the case of a girl, aged two, who died from the extension of such a growth, and Lincoln, eight additional cases in females;[3] and one instance at least is known of the growth occurring in a patient of fifty-five. Winter[4] reports an instance in a fœtus of seven months. Sands remarks that the discovery of a polypoid growth at either extreme of age would be presumptive evidence of its malignancy. Naso-pharyngeal polypi are much more frequent in males than in females (in 58 cases, 48 were males, 8 females, 2 not stated), and the precise causes of their origin are involved in complete obscurity.

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[1] Bourdilliat, Fibrome calcifié. Gaz. Méd., 1868; and H. Cloquet, op. cit., p. 688.

[2] Virchow, Die krankhaften Geschwülste, Bd. i. S. 185.

[3] Consult Giraldès; Massé, Des polypes naso-pharyngiens. Paris, 1864; D'Ornellas, Anat. path. et traitement des polypes fibreux de la base du crane, etc. Paris, 1854; Brevet, Des polypes naso-pharyngiens. Paris, 1855.

[4] On Naso-pharyngeal Polypi. Archives of Scientific and Pract. Med., No. 6, June, 1873. (Reprint.)

[5] Spence, Edinburgh Med. Jour., vol. ix. p. 996.

[6] Weber, Billroth und Pitha's Handbuch, Bd. iii. Abth. i. S. 207.

The main points in the *diagnosis* of these growths have elsewhere been touched upon. It will be sufficient to add here that malignant tumors of similar origin, intra-nasal fibrous polypi, and even syphilitic nodes and scrofulous abscesses, may, when located in the pharynx, simulate true naso-pharyngeal tumors. Cruveilhier reports a case in which a portion of the dura mater, thickened, exhibiting a fungous appearance, and containing parts of the arachnoid and pia mater, with cerebral substance and pus, formed a hernia through the cribriform plate of the ethmoid bone; and Virchow a like one, in which the tumor penetrated the palate and protruded through the mouth. Such cases, though rare, may complicate the diagnosis. An important point to bear in mind is, that the region in which true naso-pharyngeal polypi can originate is one of narrow limits, corresponding with the margins of the posterior nares and the summit of the pharynx. (Sands.)

Treatment.—For the removal of the smaller fibrous polypi, any of the methods detailed when speaking of the treatment of the gelatinoid variety, are applicable; but when the growth is large, and has invaded or displaced, not alone the nasal cavities, but likewise those in connection with them, more extensive operative procedures become necessary. In certain rare instances, naso-pharyngeal polypi have spontaneously sloughed away, or have separated from their attachments and been expelled. Such cases are reported by Johnson,[5] Birkett,[6] Saviard,[7] Bonnet, Vimont,[8] and others.[9]

Operative interference, by complete and radical extirpation of the growth, with its underlying parts and all extensions, is the only treatment upon which absolute reliance can be placed, certainly in extreme cases. It may here be briefly stated that the judgment of modern surgery is against recourse to the use of avulsion, ligature, and caustics, as means of eradicating these growths; the reasons, based on experience, are apparent to those familiar with the literature of the subject. The first method (*avulsion*) is advocated by Schuh,[10] who has had one successful case. Dupuytren, attempting the same procedure, lost his patient from hemorrhage. Cooper Forster[11] has seen it attended by fracture of the cribriform plate of the frontal bone, and death from general arachnitis and limited sloughing of the brain. Guérin's[12] plan seems no better, although it was attended by success in one case. The tumor was steadied by the left fore finger introduced behind the soft palate, and then torn from its base by means of a bone scraper introduced through the nose. Forster in one case tore the tumor from its attachments by the fingers alone. The *ligature* has also, it is true, been successfully employed in a few cases. It is, however, impracticable when the tumor is large, has numerous attachments, or is wide spread. The method of applying the ligature has elsewhere been described.[1] Michaux[2] reports an apparently successful case of its use. Gunther[3] lost a patient by the tumor having fallen, after separation from its attachment, upon the laryngeal aperture, thus causing suffocation. Other deaths are reported from pyæmia—a result to be anticipated from the presence of the large, sloughing mass in the pharynx—and from laryngeal complications. But passing mention need be made, and that in condemnation, in the present state of our surgical knowledge, of the chain-saw (Deroubaix), and of the *écraseur* (Chassaignac), although Durham and Bryant report successful cases of the use of the latter. *Caustics*, such as the actual cautery, caustic potassa, chloride of zinc, and the like, are, in the great majority of cases, not only absolutely inapplicable, but seem in all instances to stimulate increased growth. The increase of the tumor thus defies the energetic attempts made for its destruction. The *galvano-caustic ligature*, first employed by Middeldorpf in 1853, has a number of successful cases to be placed to its credit—notably, three reported by Lincoln[4]—but is open to many of the objections already alluded to. As in Dr. Lincoln's cases, it may be radical and complete in its work of extirpation, but on the other hand it often fails, and quick reproduction from the undestroyed base of the tumor is the result. The size, location, method of attachment, prolongations, and involvement of neighboring parts by the tumor, must determine the indications for its use over more severe surgical procedures. It is certainly less open to objection than the means thus far alluded to. Electrolysis has answered its destructive purpose in a few reported cases,[5] and though the process is slow, may prove satisfactory in the removal of small tumors, especially those of an erectile nature. That it is a means of anything like general application, is out of the question.[6] Nothing in the above remarks is to be construed as against the use of the actual or galvano-cautery, as a means of destruction of the base of a growth after the more radical procedures for its extirpation that are now to be considered; nor as a method of reaching parts inaccessible to the knife, even after the cavity of the pharynx has been opened from without. In both such instances they serve a useful purpose, and indeed are indicated, to destroy all possible remains of the tumor.

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[1] System of Surgery, vol. ii. p. 372.

[2] Gaz. des Hôp., 25 Mai, 1861.

[3] Arch. of Laryngology, vol. iv. No. iv.

[4] Günther, Operationen am Halse, S. 311.

[5] Brit. Med. Jour., vol. i. p. 61. 1858.

[6] Brit. Med. Jour., vol. i. p. 119. 1858.

[7] Recueil d'obs. chir., p. 112. Paris, 1784.

[8] Quoted by Brevet, op. cit., p. 16. Paris, 1855.

[9] Massé, D'Ornellas, Durham.

[10] Wiener med. Wochenschr., S. 99. 1865.

[11] Trans. Clin. Soc. Lond., vol. iv. 1871.

[12] Gazette des Hôp., p. 144. 1865.

The methods of operating for the purpose of first rendering these tumors directly accessible, and, this being accomplished, of extirpating them, remain now to be considered. I shall merely allude to the methods of procedure, which are many and varied, and to their originators. A special description of the operative steps requisite in each method, is not necessary here, and is impossible in the space allotted for this article. The subject is treated of in the majority of works on general surgery, and in other portions of this work.[7] In preparing the following summary, I have received much assistance from the valuable *brochure* of Sands already quoted, and to it I can confidently refer the reader for a succinct description of the operative procedures, illustrated with wood-cuts showing the lines of the various incisions through either mouth or face, by means of which direct access is gained to the pharynx.

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[1] See section on nasal polypi.

[2] Schmidt's Jahrbucher, Bd. cxxxiv. S. 311.

[3] Operationen am Halse, S. 313.

[4] This paper contains a record of 74 operations for naso-pharyngeal polypi in 58 patients, tabulated with the result of the operative treatment. The series embraces all cases published from 1867 to date of publication. Archives of Laryngotomy, vol. iv. No. iv. 1883.

[5] Nélaton, Med. Times and Gaz., March 16, 1867.

[6] See Althaus on the Electrolytic Treatment of Tumors.

[7] See Vol. IV. pp. 455–459, and 543, 544, *infra*.

I. *Operations through the Mouth.*—Of ancient origin, this method was revived by Maune, and still more recently by Nélaton.[1] It consists in exposing the polypus, either through an incision in the median line of the soft palate, dividing it completely or extending only to the base of the uvula, or by combining this incision with exsection of part or all of the hard palate. Massé[2] quotes twenty-six cases, in thirteen of which the results were favorable.

II. *Operations through the Face.*—This method embraces resections of some one or more of the bones of the face. The resection may be temporary or permanent; in the former case, the excised portion of the bone is replaced, after the extirpation of the tumor. This operation receives the specific name of "osteoplastic resection." The facial methods of operating, then, embrace 1st, Excision, partial or total, of the upper jaw; and 2d, Various osteo-plastic operations.

Total excision of the upper jaw was first advised for this purpose by Whateley, and practised, unsuccessfully, by Syme[3] in 1832, by Flaubert in 1840,[4] by Verneuil[5] in 1860, and since that date by Michaux and many other operators.[6]

Partial excision of the upper jaw, for the removal of naso-pharyngeal polypus, was first performed by Maisonneuve[7] in 1860, and since that date has been repeated by many operators. It is the operation commonly selected.

Osteo-plastic Operations.—Those best known are five in number, viz., the two methods devised by Langenbeck,[8] and those of Huguier,[9] Roux,[10] and Cheever.[11] Full details as to the necessary procedures will be found in the monograph of Sands. This surgeon sums up the respective merits and relative value of all of these preliminary operations for the extirpation of naso-pharyngeal polypi, as follows (I take the liberty of condensing his remarks slightly):—

Operations through the mouth have the advantage of avoiding mutilation of the face, the features being left untouched. Nor can it be denied that such operations have sometimes been done with gratifying success. If the pedicle be narrow, and the situation of attachment central, it may be dealt with thoroughly after simple section of the soft palate, and, its attachment having been destroyed, the wound in the palate may be closed at once by sutures, with every probability of securing primary union. But it must be confessed that the operation can rarely be conducted in the manner described, and the published cases prove that it has generally been found impracticable to destroy the pedicle so completely as to warrant the immediate closure of the wound in the soft palate. Accordingly, it is the practice of many surgeons to leave the wound open until the pedicle has been removed by some subsequent procedure, and afterwards to restore the palate by staphyloraphy. These facts alone prove that the method now under consideration does not afford the space requisite for the removal of a tumor having extensive attachments, and that in this respect it must be rejected as defective; moreover, it is by no means easy to destroy the pedicle afterwards, and for similar reasons. The actual cautery and various caustic applications have been employed for this purpose. In many instances, the pedicle has continued to increase in size, in spite of treatment, and the surgeon has been finally driven to the alternative of excision of the jaw to gain the desired end. Fatal results have more frequently followed operations through the mouth than those of apparently greater magnitude, so that the former operations cannot, as a rule, be recommended either for their safety or certainty—they avoid disfigurement, but do not guarantee success.

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[1] Bull. de la Soc. de Chir., tome i. p. 159.

[2] Op. cit.

[3] Edinburgh Med. Jour., vol. xxxviii. p. 322.

[4] Schmidt's Jahrbucher, Bd. xxx. S. 63.

[5] Mém. de la Soc. de Chir. Paris, 1860.

[6] See Massé (op. cit.), for details.

[7] Gaz. des Hôp. 1860.

[8] Deutsch. Klinik, S. 281. 1861; and Schmidt's Jahrb. Bd. cxii. S. 195.

[9] Bull. de l'Acad. de Méd., p. 783. 1860; and Gaz. des Hôp., p. 337. 1861.

[10] Gaz. des Hôp., p. 354. 1861.

[11] Med. and Surg. Reports of the Boston City Hospital, p. 156. 1870.

Osteo-plastic resections cause less deformity than ordinary excisions. *Langenbeck's first method*, namely, that which consists in resection of the nasal bones, has been performed several times with success, and is adapted especially to those cases in which the tumor occupies the nasal cavity, rather than the pharynx, and in which the attachments are well forwards. It certainly would not afford the requisite facility for reaching tumors which occupy the usual situation, as an examination of the cadaver alone will show. *Langenbeck's second operation*, in which portions of the malar and superior maxillary bones are temporarily displaced, is admirably adapted to the removal of those polypi which originate in the pterygo-maxillary fossa, and it is for this purpose that it was originally designed. But though it has been also done successfully for naso-pharyngeal polypi, it is inferior to several other procedures for this purpose. The operation itself is difficult of execution, unless the spheno-palatine foramen is abnormally dilated; and the pharynx is very imperfectly exposed, owing to the presence of the pterygoid process. These objections will prevent the operation from being extensively adopted.

Huguier's operation has been performed by its inventor, and, with slight modifications, by Cheever. Both patients recovered. The liability to recurrence of the disease after removal offers a strong argument against osteo-plastic operations generally.

Roux's operation involves great mutilation of the facial bones, and does not afford satisfactory access to the pharynx. To expose a tumor having broad attachments, it would be necessary to displace the maxillary and malar bones on both sides of the face, thereby greatly increasing the risks of the operation.

Cheever's operation [which involved *both* upper jaws] is ingenious, and, although it terminated fatally in the first instance in which it was performed, Sands agrees with its originator in thinking that there is no danger inherent in the operation itself that ought to prevent its repetition. [A successful case has since been reported by Tiffany.]

The objections that apply to *partial or total excisions* of the upper jaw, as a preliminary operation, are mainly owing to the disfigurement which they produce; in partial excision this is but slight. Sands remarks that these operations as a class, are remarkably successful. Lincoln,[1] that the result of a study of the table of cases[2] accompanying his paper, suggests a doubt as to the propriety of this conclusion. It will be found that among 28 cases treated by a section of the bones of the face, in several instances the growths returned, necessitating a repetition of the operation or the substitution of some other; and also that in 8 cases, or more than 28 per cent., death followed immediately, or in a few days.

Excision of the jaw certainly affords easier access to the pharynx than any of the other methods, and thus enables the operator to attack the pedicle with the maximum chances of success; accordingly, the probability of a recurrence will be correspondingly diminished. Neither the procedures through the mouth, nor any of the osteo-plastic procedures which have been described, permit that satisfactory exposure of the base of the skull which is afforded either by partial or total resection of the superior maxilla. From what has elsewhere been said, it must be evident that ample space is necessary, both for the extirpation of the tumor and for the prompt arrest of the hemorrhage that so often accompanies its removal. Another advantage of ordinary excision is, that a wide gap is left after the operation, through which the disease, should it recur, can be readily recognized and treated.

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[1] Op. cit.

[2] This table is reproduced on page 431.

SYNOPSIS OF A TABLE OF ALL PUBLISHED CASES OF OPERATION FOR NASO-PHARYNGEAL POLYPUS (NASO-PHARYNGEAL FIBROMA) FROM 1867 TO OCTOBER, 1883.

(Lincoln, Archives of Laryngology, vol. iv. No. 4, Oct. 1883.)

No. of Operations.	Number and Sex of Patients.	Age of Patients.	Operations Involving Section of Facial Bones or the Laying Open of Cicatrices Resulting from Previous Operations of this Character.	Removal by Knife, Scissors. Avulsion with Forceps, etc.	Removal by Écraseur or Ligature.	Removal by Injection or Cauterization with Chloride Zinc.	Removal by Electrolysis.	Removal by Galvano-Cautery Écraseur.[1]
74	58 Males 48 Females 8 Not stated 2	8 years, 2 14 " 6 15 " 6 16 " 3 17 " 5 18 " 3 19 " 2 20 " 1 21 " 2 22 " 1 23 " 2 } 31 25 " 1 26 " 1 30 " 1 33 " 1 } 4 35 " 1 39 " 1 40 " 2 41 " 1 42 " 1 } 6 45 " 1 47 " 1 48 " 1 52 " 2 } 5 54 " 1 55 " 1 Not stated, 8	No. operations, 39. No. patients, 28. No. cases in which recurrence is reported to have taken place within a year, 14. No. cases reported under observation for a year or more without recurrence, 4. No. cases in which there is no record subsequent to the operation, or a few months after, 13. No. deaths during or attributable to the operation, 8. In three other cases operation nearly proved fatal (Nos. 20, 23, and 46).	No. operations, 7. No. patients, 7. No. cases in which recurrence is reported to have taken place within a year, 0. No. cases reported under observation for a year or more without recurrence, 1. No. cases in which there is no record subsequent to operation, or a few months after, 5. No. fatal cases, 1 (No. 21).	No. operations, 12. No. patients, 11. No. cases in which recurrence is reported to have taken place within a year, 6. No. cases reported under observation for a year or more without recurrence, 4. No. cases in which there is no record subsequent to operation, or a few months after, 2. No. fatal cases, 0.	No. cases treated, 2. No. cases in which recurrence is reported to have taken place within a year, 1. No. cases in which there is no record after the discontinuance of treatment, 1. No. fatal cases, 0.	No. cases treated, 3. No. cases reported under observation for a year or more without recurrence, 1. No. cases in which there is no record after the discontinuance of treatment, 2. No. fatal cases, 0.	No. operations, 11. No. patients, 10. No. cases in which recurrence is reported to have taken place within a year, 3. No. cases reported under observation for a year or more without recurrence, 6. No. cases in which there is no record subsequent to operation, or a few months after, 2. No. fatal cases, 0.

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[1] In this class is included one case treated by means of the actual cautery (No. 70).

Partial excision of the jaw, according to the plan of Maisonneuve, will in most cases fulfil all the indications presented. Partial excision affords an excellent view of the pharynx, and leaves the patient with very slight external disfigurement. The orbital plate and malar tuberosity being left intact, the eyeball does not descend from its normal position, and the prominence of the cheek remains—which is not the case after complete excision. The skill of the dentist can readily imitate the lost portion of bone, and the gap in the palate can be closed, partly by staphyloraphy, and partly by an obturator made of hard rubber.

Of all the operations mentioned, then, which are applicable to grave cases, Dr. Sands gives the preference to partial excision of the upper jaw, as the one which is adapted to favor the most complete removal of the tumor with the least practical disfigurement. In this view he is in accord with the majority of surgeons of the day.

CARTILAGINOUS GROWTHS have elsewhere been alluded to (page 409) as occurring not infrequently upon the septum, more in the form of general thickening of its cartilaginous portion than as distinct tumors, and often associated with deviation of the cartilage. Large cartilaginous tumors springing from either the ethmoidal cells or frontal sinuses are very uncommon, and but few instances are upon record.[1] They usually affect young persons, cause frightful deformity, and lead to the early death of the patient. When small, they may perhaps be removed by means of the knife, gouge, or chisel, through the nasal opening; but if large, with deep attachments to the base of the cranium, or, perhaps, lying in contact with the under surface of the brain, as is usually the case, operative interference is out of the question.

OSSEOUS GROWTHS.—Bony formations of various classes are found within the nasal passages. First, exostoses, developed from the bony portion of the nasal septum or floor of the nostril, which are common; likewise tumors springing from some neighboring bone and invading secondarily the nose; or growths which may be the result of strumous or syphilitic disease of the osseous framework of the nasal cavity, and into the formation of which cartilage may enter in variable proportion and disposition.[2] Second, ossified cartilaginous or sarcomatous growths. (Mackenzie.) And third, a remarkable form which is to be carefully distinguished from the true exostoses, whether cancellated, compact, or eburnated, and from the mixed bony and cartilaginous growths just alluded to; instances of this form are reported by Legouest, Duka,[3] Michon,[4] and Dolbeau,[5] and the whole subject is elaborately treated of by Ollivier.[6] In all such cases the bony growth is developed from between the layers of the nasal mucous membrane or periosteum which lines the cavities, independently of any apparent disease of the parts which envelop it, and always remains free and movable; it may take its origin in the frontal sinuses or in the nasal fossæ, and by slow growth may attain a considerable size. It has been suggested that these growths may be analogous in their mode of development and subsequent separation to the antlers of the *Cervidæ*. (Durham.) Thudichum[7] adds that exostosis of the turbinated bones is an occasional complication of nasal polypus.

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[1] See Ure, Stanley, and Prochaska (Disquisit. Anat.-physiol. Organismi. Corp. Human., p. 172. Viennæ, 1812); also, Cooper's Surgical Dictionary.

[2] Trélat and Dolbeau, Bull. de la Soc. de Chir., 1862, p. 261; and Morgan, Guy's Hosp. Reports, series i., vol. i. p. 403; *sequel*, series i., vol. vii. p. 491.

[3] Path. Trans., vol. xviii. p. 256; vol. xix. p. 311, another case.

[4] Mém. de la Soc. de Chir. de Paris, tome ii.

[5] Bull. de l'Acad. de Méd., tome xxxi. p. 107.

[6] Sur les Tumeurs osseuses des Fosses nasales. Paris, 1869.

[7] Lancet, Sept. 1868.

Bony tumors vary somewhat in their character and formation; some have a hard, ivory-like density; others are soft and friable; they are often interspersed with small cavities, occupied with gelatinoid, fibrous, or cartilaginous matter; but whether compact or cancellated, they always present the characteristic arrangement of the Haversian canals. Their removal is effected by cutting off their attachments with the knife, saw, pliers, or chisel, either through the nose, or, if the mass be very bulky, by an opening through the face. (Gross, Mott.[1]) Ollivier suggests that the cancellated variety may be crushed up, and then extracted without enlarging the natural opening of the nose. Cohen,[2] in a case of exostosis developed from the palatine ridge of the superior maxilla, and in the vomer, ground the offending mass away through the natural passage with the burr of the dental engine, the parts being exposed by detaching the overlying mucous membrane and periosteum, which were replaced after the exposed surfaces had been carefully polished by the corundum wheel. Similar cases have been reported to me by Clinton Wagner.

The curious "osseous tumors" above referred to, require free and complete exposure of the cavities in which they lie, and may then be turned out without difficulty. (Legouest.[3]) If allowed to remain *in situ*, they finally cut off their own nourishment by pressure, and slough out through the tissues which envelop them. (Hilton.[4])

SARCOMATOUS GROWTHS.—The tendency which fibroid polypi, cartilaginous tumors, and even simple gelatinoid growths, occasionally exhibit to degenerate into sarcomata, has been alluded to; but aside from these sources, sarcoma may develop primarily, with all the characteristics belonging to its class. Its differential diagnosis from carcinoma is difficult: both present in the nasal cavities many appearances, and give rise to many symptoms, that are in common. The main points in differentiation have already been touched upon (page 421).

Sarcoma usually shows itself, in the nasal passages, as a dark-red, fleshy-looking, lobulated mass, with prolongations and attachments stretching in different directions; its consistence varies, being either of a dense hardness, or with a soft and fluctuating feel. It is exceedingly vascular, and its growth rapid, especially in children, where the adjacent cavities, particularly the cranium, orbit, and pharynx, are often invaded almost simultaneously.

It is unquestionably the surgeon's duty, especially in the earlier stages of the affection, to attempt the extirpation of the neoplasm by some one of the operative procedures which have been described. This extirpation must, however, be radical, and must be successful and complete at the first attempt, or disaster is sure to follow; recurrence of the tumor is always attended with increased rapidity of growth, and with marked access of malignancy.

CARCINOMA.—The rarity of true cancer originating within the nasal passages, is conceded by all writers. Watson[5] holds that the recorded instances are, for the most part, either examples of fibrous or sarcomatous tumors that have undergone softening and degeneration, with perhaps fungous protrusion, or cases of encephaloid disease which has originated in the meninges or cranial bones, and which has made its way through the ethmoid and sphenoid bones, into the orbit and nostril.[6] The disease occurs either in young children, or in those past middle life. Its destructive inroads are widespread and terrible, and, as it is necessarily fatal, palliative measures alone can be adopted; all experience deprecates any recourse to operative interference.

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[1] American Journal of the Medical Sciences, January, 1857, p. 35.

[2] Op. cit., p. 400.

[3] Mém. de l'Acad. de Méd., 1865–66, p. 147.

[4] Guy's Hosp. Reports, series i., vol. i. p. 495.

[5] Op. cit., p. 286.

[6] Out of fifty-one cases of meningeal cancer analyzed by Velpeau, seven presented themselves in the orbito-nasal region, and in several of these the tumor appeared in the nostril, and caused symptoms commonly referred to malignant polypus.

The remaining varieties of tumor that may occur in the nasal passages, are very infrequent, and demand but passing notice.

Adenoma is developed from the glands of the mucous membrane, and may not only attain a great size, but may reach from the nasal passages into all the adjacent cavities.

Neuroma.—A case is reported by Gerdy,[1] in which a neurilemmatous tumor, connected with the second branch of the fifth pair of nerves, made its way into the nostril through the spheno-palatine foramen. Attempts at evulsion, the growth having been mistaken for a nasal polypus, resulted in meningitis and death.

Echinococci.—Fraenkel[2] refers to the presence of these tumors, which he regards as of rare occurrence.

Cysts.—True cystic tumors occasionally occur in the nasal cavities proper, and originate in the lining mucous membrane. I have seen and treated one such case, in which the tumor, closely resembling an ordinary mucous polypus, both in color and configuration, was seen by posterior rhinoscopic examination to be situated in the left posterior naris; seized by the polypus-forceps, it burst, discharged its contents, and all vestiges quickly disappeared; there was no recurrence.[3] A similar case, the cyst being located in the right posterior naris, is reported by Johnson,[4] and others by Seiler[5] and Ingals.[6]

Neuroses of the Nasal Passages.

The olfactory nerve is the only one upon whose integrity depends the sense of smell. After passing the lamina cribrosa of the ethmoid bone, its branches, as is well known, are distributed in the mucous membrane covering the upper part of the septum, to a limited extent, and more richly to that covering specially the upper turbinated bone and perhaps the upper part of the middle one. The epithelium of these parts has a special arrangement, also, which differs from that of the lower portion of the nasal passage, and which may have some special relation to the function of olfaction. The terminal branches of the nerve are probably in immediate connection with certain peculiar terminal organs, which receive olfactory impressions and conduct them to the nerve-fibres. Nothing certain, however, is known in regard to the central course of the olfactory nerves; the so-called external root contains the greater number of fibres, and may be traced centrally into the neighborhood of the island of Reil. (Erb.) The first and second divisions of the fifth pair constitute the true sensory nerves of the mucous membrane of the nose; they conduct tactile and common sensations, but are uninfluenced by odorous substances.[7] These anatomical and physiological facts have a direct bearing, as will be seen, upon the various neuroses to be considered. It may be appropriate to here likewise recall to recollection the necessity for carefully distinguishing between the sense of taste and that of smell, in investigating a supposed case

[1] Des Polypes, p. 110.

[2] Ziemssen's Cyclopædia, vol. iv. p. 171.

[3] Phila. Medical Times, Dec, 15, 1883.

[4] British Medical Journal, May, 1874.

[5] Phila. Med. Times, vol. xiv. No. 423, Feb. 9, 1884.

[6] Chicago Med. Review, vol. ix. No. 5, Feb. 2, 1884.

[7] See also Althaus, The Physiology and Pathology of the Olfactory Nerve. Lancet, May 14, 1881, *et seq.*

of loss of the latter, and to the rules for determining whether such loss is limited to one nasal passage, or affects both. It is no unusual matter for individuals affected with anosmia to declare that the sense of taste is also lost, and this because they are unable to perceive differences of flavor, a matter of olfaction alone. Careful examination and test of the gustatory sense will show, however, that the taste of acid, sweet, bitter, and saline substances can be perceived—perception of flavor alone is in abeyance. In other words, if smell be lost and taste preserved, flavors can no longer be distinguished, though simple perceptions of taste remain. This is true, as a rule; but even though there be complete inability to appreciate odorous substances inhaled through the nose, perception of flavors may still exist in certain cases. This can only happen, however, when the posterior nares and passage between the velum and posterior pharyngeal wall are free; in cases where the anterior nasal openings and passages are occluded, the odorous particles of food and fluids reach the olfactory region through the posterior nares alone. Ogle[1] reports two interesting cases in which the posterior nares were obstructed in consequence of the adhesion of the soft palate to the posterior wall of the pharynx; in both, the sense of smell and power of perceiving flavors were completely lost. In one, an artificial opening was made through the soft palate, and both olfaction and perception of flavors were again restored as soon as the communication was established.

Loss of smell may affect one side of the nose alone; in such instances the patient may not be aware of his defect, and the surgeon can only prove it by carefully testing each olfactory region separately, the nostrils being alternately held closed. For this test, articles must be chosen that are truly odoriferous, and not irritant to the sensory fibres of the fifth nerve. Ammonia, snuff, and the like, are thus to be avoided, and the test made with cologne-water, musk, camphor, or any of the volatile essential oils. That the test may be complete, and the fact proven that complete anosmia exists, it is well to experiment likewise with the perception of flavor in the given case. Coffee, wine, liqueurs, and many other articles, depend for their agreeable flavor upon the participation of the sense of smell with that of taste. If complete anosmia exists, flavor is lost, as has been shown, even though the posterior nares be patent.

The neuroses referable to the nasal organ are those of olfaction, sensation, and motion.

ANOSMIA may be caused, in the first instance, by any condition of the nasal passages that gives rise to obstruction, or renders the action of odorous substances upon the olfactory apparatus impossible; and secondly, by impaired function or destruction of the nerve-filaments distributed in this olfactory region, or by impaired function or destruction of the olfactory bulbs themselves. It is understood that the term anosmia is applied only to such cases as those in which the intensity of the perception of smell is progressively diminished until extinguished, without the sensibility of the mucous membrane to irritant substances being affected; thus, tobacco, for instance, will cause sneezing, though its peculiar smell be not perceived.

Any obstruction to the entrance and free passage of air to the upper portions of the nasal passage, may constitute an efficient cause of anosmia. The commoner causes are probably chronic hypertrophy of the tissues, as seen in old standing cases of catarrh; the presence of thick, dry crusts and secretions, nasal polypi, and finally, as a common temporary cause, acute inflammation—coryza or influenza. Among the rarer causes may be mentioned anæsthesia of the trigeminus, with diminished or suppressed nasal and lachrymal secretion, and hence an abnormally dry nasal mucous membrane, incompatible with the exercise of the full function of smell; occlusion of the nostrils from congenital or accidental causes; paralysis of the dilator muscles of the nostrils (paralysis of the portio dura of the seventh pair); and occlusion of the pharyngeal or post-nasal cavities as the result of syphilitic cicatricial contraction, or other mechanically occluding causes elsewhere mentioned.

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[1] Med.-Chir. Trans., vol. liii. p. 273. 1870.

Ogle dwells upon the importance of the pigment of the olfactory region for the integrity of the sense of smell, and quotes an interesting case in support of his views.[1]

Various pathological lesions, which involve—perhaps destroy—the terminal distributions of the olfactory nerve, secondarily give rise to anosmia. Such lesions are not infrequently seen in the various idiopathic, traumatic, and constitutional affections of the nose already alluded to. Watson believes that certain cases of anosmia, after severe catarrhal attacks with violent sneezing, may be due to local mischief implicating the fibres of the nerve in the olfactory region,[2] or to hemorrhage which has taken place into the olfactory bulbs. In Virchow's Archives,[3] a case is recorded in which the continued, accidental inspiration of the fumes of ether caused a gradual failure of the sense of smell, and at last its total abolition, the effect being attributed to the continuous contact of the drug with the minute branches of the olfactory nerve.

Finally, cerebral disease, either directly or indirectly involving the olfactory bulbs, and impairing their nutrition and functional activity, gives rise to loss of smell. These cases, too, are not infrequently associated with subjective derangements of olfaction, the subjective odor being usually complained of as offensive.

Hughlings Jackson calls attention to effusion into the lateral ventricles as a possible cause,[4] through pressure on the olfactory bulbs. Blows upon the head, whether on the forehead, parietal region, vertex, or occiput, have long been recognized as causes of anosmia. Hilton attributes this result to rupture of the olfactory bulbs, or their separation from their beds, owing to the fact that they lie directly on the floor of the cranium, unprotected by a cushion of cerebro-spinal fluid, as are the parts of the base of the brain behind the bulbs. Ogle believes that it is due to rupture of the olfactory nerves as they pass from the bulb through the perforations in the ethmoid bone. The further deductions and conclusions reached by him, in his admirable article, may be thus summarized: Anosmia of the affected side is present in every well-marked case of facial palsy. He believes that the external root of the olfactory nerve is the only one directly concerned in olfaction, and that it depends upon the degree in which this root or its central termination has been disorganized, whether the loss of smell is complete or partial. In support of this view, he cites an observation of M. Serres[5]—founded on the results of nineteen post-mortem examinations of the bodies of paralytic patients—that lesion of the external is much more efficacious in determining anosmia than is lesion of the internal root. Wickham Legg[6] and Hybord[7] have shown that anosmia may not develop until several months after an injury to the skull, and then as the result of an extension of inflammatory or other processes. Prevost has demonstrated degeneration and atrophy of the olfactory nerve as the cause of senile anosmia. Notta[8] has reported instances of congenital loss of smell, in which the absence of an olfactory tract was shown to be the cause by Rosenmuller and Pressat. Cases of anosmia which accompany aphasia and dextral hemiplegia, and are always limited to the left nasal cavity, are to be credited to Jackson, Fletcher, Ransome, Ogle, and Erb. The latter holds that the loss of smell occurring so frequently with hysteria is of central origin, and associated, as a rule, with loss of taste and with cutaneous and muscular anæsthesia. The anosmia of the insane may likewise be attributed to central lesion.

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[1] Am. Jour. Med. Sci., 1852.

[2] Op. cit., p. 337.

[3] Archiv für path. Anat., Bd. iv. S. 41. 1867.

[4] Med. Times and Gaz., Oct. 17, 1874.

[5] Anatomie Comp. du Cerveau, t. i. p. 295.

[6] Lancet, Nov. 8, 1873.

[7] Arch. Gén. de Méd., Mars, 1874.

[8] Recherches sur la Perte de l'Odorat. Arch. Gén. de Méd., Avril, 1870.

Treatment, as a rule, is not encouraging in its results. If the cause of the anosmia be central, its cure is probably hopeless; while if it be dependent upon mere mechanical obstruction to the entrance of the odoriferous particles to the olfactory region, it can be relieved, in the majority of instances, by removal of the impediment, by the means alluded to when treating of the various conditions of the nasal passages which give rise to occlusion or obstruction. Treatment must, then, in many instances at least, be limited to that of the primary disease, and to the removal of ascertained and present causes. Direct treatment of the affected parts, viz., the upper portions of the Schneiderian membrane, should always, however, be undertaken in the hope of success, and electric excitation by means of the interrupted galvanic current is indicated if treatment of the primary cause is not followed by restoration of the sense. Cohen[1] has found that, under certain circumstances, the only way in which he could arouse the sensation of smell was by using the covered negative electrode in the nasal passage, and the positive electrode over the course of the sympathetic nerve behind the angle of the jaw. Moller[2] applies strychnia with a brush to the nasal mucous membrane with good results. Notta gained only negative results with irritating snuffs, but calls attention to an important fact that should be remembered, viz., that many chronic cases recover even without any treatment.

HYPERÆSTHESIA.—Abnormal acuteness of smell may exist to such a degree as to cause intense annoyance and even distress to its unfortunate possessor. Numerous well-authenticated and curious examples are upon record, as, for instance, that of Anne of Austria, who fainted upon inhaling the odor of roses. But, on the other hand, many absurd claims are based upon the alleged acuteness of the sense: thus, it has been claimed that smell alone is adequate to the recognition of syphilis; that the difference between pneumonia and bronchitis may be detected by the nose alone; and even that recent participants in coitus may be distinguished by their peculiar odor.[3]

Other facts in relation to increased development of this special sense are of more diagnostic and practical value. Hysterical patients not infrequently can distinguish the most minute traces of odorous substances; subjective sensations of smell occur both in epileptics,[4] when they usher in the seizure, and in insane patients;[5] nervous disorders of various kinds, as well as the most various forms of cerebral disease,[6] are occasionally complicated by derangements of olfaction; and tumors, softening, and degeneration of the olfactory nerve, are associated with like phenomena, which disappear with the complete destruction of the nerve and the establishment of anosmia.

STERNUTATIO, OR EXCESSIVE SNEEZING, may be the direct result of simple irritation of the Schneiderian membrane, especially if this be hyperæsthetic, the stimulus being transmitted through the fifth nerve to the medulla, and thence reflected, mainly to the muscles of respiration; or the cause may be central, as in the curious cases where it is excited by the emotions: thus, Stalphat van der Weil[1] reports instances in which coitus was always preceded by violent paroxysms of sneezing;[2] Schubart, one of a young girl, who for several nights suffered from fits of sneezing, repeated three hundred times and more on each occasion; Albrecht, again, relates one of an infant in whom sneezing occurred one hundred times an hour, and caused death (Watson); and Mosler, the case of a girl with an ear affection, a sequel of typhoid fever, where the paroxysms lasted twenty-four hours. More modern instances also are not wanting in profusion.[3]

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[1] Op. cit., p. 403.

[2] Rev. des Sci. Méd., Oct. 1876.

[3] See also Isham, On Smell in the Diagnosis of Disease (Cincinnati Lancet and Clinic, Oct. 9, 1875); and Clinton Wagner, On Smell, hygienically and medico-legally considered (The Æsculapian, Feb. 1884).

[4] Hughlings Jackson, Med. Times and Gaz., Aug. 13, 1864.

[5] Forbes Winslow, On Obscure Diseases of the Brain, etc.

[6] Manigault, Dubois, Westphal, Sander, Schlager.

As a rule, the affection, if it may be so termed, is an unimportant one, especially in the first class of cases alluded to; but that serious results may follow prolonged and violent attacks of sneezing can be readily appreciated. Epistaxis, hæmoptysis, menorrhagia, and even cerebral hemorrhage, have been known to ensue, as well as, in rarer instances, amaurosis from retinal hemorrhage, epilepsy, abortion, and sudden death from rupture of an aneurism. (Watson, Cohen.)

Treatment.—In many cases of hyperæsthesia dependent upon the central causes outlined above, the treatment of the symptom is useless, being unattended by any good result. If sneezing be dependent only upon hyperæsthesia of the mucous membrane, the local use of sedative ointments, such as stramonium, aconite, and camphor, will play a useful part. If due to hysteria, preparations of assafœtida and valerian (Cohen), valerianate of iron, and the use of a weak solution of aq. laurocerasi, snuffed up the nostrils (Mayer), and the inhalation of tobacco snuff (Gray), may be employed; while if it occur in the course of a neuralgia of the facial nerve, sedatives are indicated, with tonics.

SPASMODIC TWITCHING OF THE NOSE, if not the result of mere habit, probably depends upon chorea, and is associated with similar convulsive muscular contractions of the face, or even of the body. The indications for treatment suggest themselves.

PARALYSIS OF THE NOSTRILS is probably a partial manifestation of paralysis of the facial nerve, though it may exist, it is true, but rarely, as a purely local affection. It amounts to a serious inconvenience only when both nostrils are affected, and oral respiration becomes a necessity. The nature of the treatment must depend upon the cause of the paralysis; locally, the use of the electric current is indicated.

Nasal Cough, and the Existence of a Sensitive Reflex Area in the Nose.—Attention has been called, in a previous section of this essay, to the fact that violent or paroxysmal cough is not infrequently a symptom of nasal disease, and is specially attendant upon those pathological conditions which affect the inferior turbinated bones. J. N. Mackenzie[4] has investigated the question both experimentally and clinically, and in an interesting paper has given his results or conclusions as follows:—

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[1] Obs. Rares de Médecine, etc.

[2] See, also, J. N. Mackenzie, Irritation of the Sexual Apparatus as an Etiological Factor in the production of Nasal Disease (Am. Jour. Med. Sci., April, 1884).

[3] Russell, case due to cerumen (Brit. Med. Jour., vol. ii. p. 937. 1879); Woakes (Lancet, March, 1880, p. 253); also Lancet, Nov. 1873, p. 864; Brit. Med. Jour., Jan. 1889, p. 90; Ibid., Dec. 1879, p. 1021.

[4] Am. Jour. Med. Sciences, July, 1883.

1. In the nose there exists a well-defined sensitive area, the stimulation of which, either through a local pathological process, or through the action of an irritant introduced from without, is capable of producing an excitation which finds its expression in a reflex action or in a series of reflected phenomena. 2. This sensitive area corresponds, in all probability, with that portion of the nasal mucous membrane which covers the turbinated corpora cavernosa. 3. Reflex cough is produced only by stimulation of this area, and is only exceptionally evoked when the irritant is applied to other portions of the nasal mucous membrane. 4. All parts of this area are not equally capable of generating the reflex act, the most sensitive spot being probably represented by that portion of the membrane which clothes the posterior extremity of the turbinated body, and that of the septum immediately opposite. 5. The tendency to reflex action varies in different individuals, and is probably dependent upon the varying degree of excitability of the erectile tissue. In some, the slightest touch is sufficient; in others, chronic hyperæmia or hypertrophy of the cavernous bodies seems to evoke it by constant irritation of the reflex centres, as occurs in similar conditions of other erectile organs. 6. This exaggerated or disordered functional activity of the area may possibly throw some light on the physiological destiny of the erectile bodies. Among other properties which they possess, they act as sentinels to guard the lower air-passages and pharynx against the entrance of foreign bodies, noxious exhalations, and other injurious agents to which they might otherwise be exposed.

INJURIES TO THE NOSE.

FRACTURES OF THE NASAL BONES are caused by severe blows or falls upon the organ. If the force comes from before and from above, a transverse fracture is usually the result, within from three to six lines of the lower and free margins of the nasal bones, and the fragments are simply displaced backwards; or if the blow is received partially upon one side, they are displaced more or less laterally. Greater force will generally break the ossa nasi transversely, and a little above their middle, while at the same time the nasal processes of the superior maxillary bones may be slightly involved; and finally, the amount of force requisite to break in the nasal bones at their upper third is very great. Hamilton[1] asserts that if they do yield at this point, there is no doubt but that the base of the skull must yield also, and that patients can hardly be expected to recover from so severe an accident. In children the nasal bones may be spread and flattened, the lateral margins not being depressed or displaced, but only the mesial line or arch forced back so as to press aside the processes of the superior maxillæ. This deformity may become permanent. (Hamilton.)

The attendant injury to the soft parts, and the rapidity with which swelling ensues after these accidents, render the diagnosis at times difficult. Careful inspection and palpation, if at once instituted, rarely fail, however, to establish the fact, and crepitation, which can usually be felt, especially if the fracture be multiple, confirms it. Bleeding, which may be so profuse as to endanger life, commonly attends the accident, and if the lachrymal bone be involved, emphysema of the eyelids and of the cellular tissue of the orbit, due to an escape of air from the nose, will exist.

Gross[2] calls attention to the fact that sometimes violent cephalic symptoms attend these fractures, depending upon the intimate connection between the nasal and frontal bones, which permits the jarring effects of the blow or fall to be communicated to the brain and its envelopes. Danger to life is to be apprehended, however, only when there is serious cerebral involvement, as when the lesion is associated with fracture of the cribriform plate of the ethmoid bone, separation of the dura mater at the anterior part of the base of the skull, copious effusion of blood, or severe concussion of the brain. Under such circumstances the patient may die from shock, from compression, or from inflammation.

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[1] Fractures and Dislocations, p. 90.

[2] System of Surgery, vol. i. p. 946.

Reduction of the fractured bones if undertaken early, before swelling has masked the field of operation, is usually readily accomplished. External manipulation alone may succeed in replacing the fragments, but usually the combined method—the finger externally, and some small instrument, a straight steel director or a sound passed up into the nasal cavity—will be necessary. By these means the loose fragments are gently pressed back into position; to hold them there, however, is no easy matter; the swelling of the soft parts has a constant tendency to depress them, unsupported, as they are, by any counter-force. The use of pledgets of lint or compresses within the nose, is deprecated by all modern writers, as practically useless and painful to the patient. Hamilton only advises them in cases where the amount of comminution of the bones is great. The same is true of canulas, hollow bougies, and the like. When the fragments exhibit a tendency to become depressed or to fall asunder, after they have been replaced, Gross recommends that they be held in position by a stout adhesive strip carried across the bridge of the nose from one cheek to the other, and Hamilton uses nicely adjusted compresses made of soft cotton or lint, and secured upon the outside of the nose with delicate strips of adhesive plaster, or rollers, to accomplish the same result. Mason,[1] in fractures of the nasal bones with depression of the bridge, and also of the nasal processes of the superior maxillæ, recognizing the difficulty of holding the fragments in place after reposition, suggests the following method: pass an ordinary surgical needle, nickel-plated or gilded, and by means of a strong needle-holder, through the line of fracture of the nasal processes on either side. After the parts have been replaced in position, this affords not only a posterior support to the nasal bones, but acts as a tie-rod holding together the sides of the nasal arch. To complete the dressing, a small strip or ribbon of pure rubber-bandage is placed over the bridge of the nose, by puncturing either end on the head and point of the needle, giving the rubber sufficient tension to exert a gentle downward and lateral compression, but not enough to interfere with the circulation of the part, or to exert injurious pressure on the fragments. At the end of about the sixth day the needle may be withdrawn, for the less serious forms of these fractures are repaired with great rapidity and without the interposition of provisional callus, and therefore the need of constant supervision and readjustment of the apparatus, which is required in whatever method be employed, will not long tax the surgeon. The amount of deformity sometimes resulting from apparently an insignificant amount of injury, warrants, however, careful attention to both. To relieve the deformity resulting in old cases where fractures of the nasal bones have either been left unreduced, or where the result of treatment has been bad—no unusual occurrence—various methods have been suggested. That recommended by Adams in cases where the septum is also displaced, has been alluded to elsewhere. Weir,[2] not satisfied with the results gained by Adams's method of refracturing and readjusting these old fractures of the nasal bones with lateral displacement, and believing, as the result of several trials, that the Adams forceps is too large at its end to be satisfactorily carried up under the nasal bones, and that the fracturing force is not ample enough, has devised a new procedure. This is nothing less than to perform an osteoclastic operation, or, in more ordinary words, to make an incision—not directly to the bone, but bevelled, as Packard, of Philadelphia, has suggested, as creating the least cicatrix—not more than one-eighth or a quarter of an inch long, over the greatest convexity of the bony deformity and parallel to the free border of the nose, so as to, as nearly as may be, strike the naso-maxillary junction, and then, by the introduction through this small cut of a very narrow chisel, to cut through the bone with a few strokes of the mallet; if the tilting action of the imbedded chisel prove insufficient to loosen the other side of the nose, it is only necessary to chisel that side also through the same incision, which is the only one required. Replacement can now be effected with ease and rapidity, and the retention of the nose in its corrected position is readily accomplished. If depression also exist, the elevation of the refractured bone is brought about by pushing it upwards by an instrument from within the nose. A piece of sticking plaster rolled up with the sticky side out is now laid along the nose on its formerly prominent side, to form a compress, and another strip drawn across this and the face, to hold everything snugly in its place. A nose truss, a modification of that of Adams, may be worn for a few days.

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[1] Annals of the Anat. and Surg. Society. Brooklyn, March, 1880.
[2] Med. Record, March 13, 1880.

DISLOCATION OF THE NASAL BONES is a very infrequent accident, and cannot occur except as the result of direct violence, nor unless associated with dislocation of the septum. Fracture of the cribriform plate of the ethmoid bone may likewise coexist, and may very seriously complicate the condition, through the injury which the displacement of its fragments may inflict upon the brain or its membranes.[1] Considerable force is necessary to replace the nasal bones when dislocated backwards, mainly because they are jammed between the nasal processes of the superior maxillary bones, which hold them tightly. Once replaced, however, by the same means that are used in fracture of the nasal bones, no retentive apparatus is required.

WOUNDS OF THE NOSE, whether they be contused, incised, or lacerated, demand careful treatment, in view of the possible future deformity. In the case of incised or lacerated wounds, accurate coaptation of the edges of the wound by means of numerous fine sutures, the readjustment of the parts in their normal position, and their retention by means of delicate adhesive strips, demand careful attention and good surgical skill. Primary union is the rule, unless there be much contusion of the parts. The question whether an incised wound, resulting in partial or total separation of a portion of the nose, can be followed by complete union of the severed part even after it has been separated from the main portion of the organ for a considerable time, is answered in the affirmative by Watson,[2] and a number of curious and interesting illustrative cases are given by him in support of this position. In any doubtful case, it will be wise, he holds, to give the patient the benefit of the doubt. The detached portion should be carefully cleansed, the raw surface of the stump revivified by scarification, and the parts adapted to each other, and then retained in position by strapping—if possible without sutures. Cotton-wool steeped in collodion, used as a dressing to the edges of the wound, has the advantage of rendering a support to the parts which other dressings do not.

INJURIES TO THE NOSE WITH THE LODGMENT OF FOREIGN BODIES, are almost exclusively met with as the result of gunshot-wounds with penetration and lodgment of the ball. The history of the case, the presence of scars or fistulæ, and the result of a careful exploration of the parts as detailed when speaking of the treatment of foreign bodies in the nose, usually leave no room for doubt as to the nature of the injury, even though a considerable time has elapsed since its reception. Interesting cases are given of this form of accident by Williamson[1] and Lawson;[2] in the case recorded by the latter, the right cavity of the nares was necessarily laid open by incision, to afford space for the extraction of the foreign body, a portion of the breech of a fowling-piece that had exploded in the patient's hands. A somewhat similar case, reported by Noyes, is alluded to elsewhere in this essay.

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[1] Longuet (On the Luxation of the Nasal Bones), Rec. de Mém. de Méd., etc., tome xxxvii. p. 280. Paris, 1881.

[2] Op. cit., p. 295.

BURNS AND SCALDS OF THE NOSE are of special importance, in view of the possible distortion of the organ, of the partial closure of one or both nasal orifices by cicatricial tissue, or of the results of cicatricial contraction if the lesion be at all extensive. Their ultimate effects exceed therefore in gravity those which are immediate, and are to be guarded against during the healing process by promptly meeting the indications that suggest themselves. The operation necessary for the restoration of the calibre of the nostril has already been considered.

DEFICIENCIES AND DEFORMITIES OF THE NOSE.

CONGENITAL ABSENCE OF THE NASAL ORGAN is a rare condition. A case is reported by Maisonneuve,[3] in which the nose of a female infant of 7 months was replaced by a plane surface, merely pierced by two small holes. Other cases are said to be upon record, but I am unable to find them. Holmes regards the malformation as incurable.

CONGENITAL CLEFTS AND FISSURES OF THE NOSTRILS are simply prolongations of the natural opening, outwards into the cheek, or upwards towards the angle of the eye. They are very unusual, and as a rule can be closed by plastic operations.

DOUBLE NOSE.—Dr. S. W. Gross has related to me the particulars of an interesting case of this unusual condition. The auxiliary organ, apparently an outgrowth of the first, was of about one-half its size, and into it the tear-duct opened. Borellus[4] mentions a similar case, and Bartholinus[5] one in which a little tumor, like a second nose, grew on the root of the principal or normal one. (Watson.) There would probably be no great difficulty, in such instances, in remedying the deformity by a simple operation.

CONGENITAL OCCLUSION of the *nostrils* and of the *posterior nares* has been elsewhere considered (see page 404).

SLIGHT DEFORMITIES IN THE SIZE AND POSITION OF THE NOSE are commonly seen. The central portions of the face and skull are but slowly developed, when compared with the rate of growth of other parts, and this is particularly true of the frontal eminences and the sinuses communicating with the nose. Thus, the latter organ in the infant always presents a flattened appearance, which may persist in later years. The same reason suffices to account for other well-known deviations from the normal contour. Harrison Allen[6] has called attention to an asymmetrical rate of growth of the visceral arches, which prevents the perfect shaping of the oral and nasal cavities: one arch being more actively developed than its fellow, one nasal cavity will be found narrowed and obstructed, the other abnormally large, and the septum deflected from the median line. In such cases of congenital deformity, the teeth also are irregular, especially the permanent incisors; the two halves of the upper dental arch are V-shaped, and the vault of the mouth is high and narrow. The nose will thus be rendered misshapen, prominent, and projecting, not only on account of the high-pitched hard palate which pushes its parts forward, but likewise on account of the retarded growth of the perpendicular plate of the ethmoid, which prevents its normal development posteriorly. The marked influence which the cartilaginous septum plays when congenitally misshapen or distorted, in producing a lateral distortion of the nose in its external contour, has been already alluded to (see page 407), and the operative measures necessary for the relief of that condition have been described. When nasal bones and alæ as well as septum are laterally distorted, surgical attempts at remedying the condition are not attended with much success; and, unless the deformity be excessive, which is rarely the case, had better not be undertaken. Various "nose-machines" have been devised to effect a cure by straightening the organ mechanically; one consists of two parallel plates of iron, well padded inside, and properly curved so as to adjust themselves to the shape of the nose to be operated upon. The upper and lower portions of these plates are furnished with screws, passing horizontally from one plate to the other, so that they may be properly adjusted as regards the degree of compression. Another apparatus consists of a metallic arm, fastened to a head-band, and furnished at its end with a small pad, which, when the instrument is in position, is so arranged as to press directly upon the point of greatest convexity of the distorted nose; the degree of compression is regulated by means of a cog-wheel joint. It is possible that, could the patient be induced to wear either of these forms of apparatus for a sufficiently long time, some change in the position of the nasal parts would follow.

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[1] Quoted by Watson, op. cit.

[2] Diseases and Injuries of the Eye, 2d ed.

[3] Bull. de Thérap., tome xlix. p. 559. 1855.

[4] Hist. et Obs. Medico-physic. Cent. III., Obs. 43.

[5] Hist. Anat. Rar. Cent. I. Hist. 25.

[6] Phila. Med. Times, Dec. 6, 1879.

THE SEVERE DEFORMITY WHICH FOLLOWS INJURIES AND CERTAIN DESTRUCTIVE DISEASES, such as lupus, erosive syphilitic ulcer, and the like, and which involves not unfrequently parts of the cheeks and lips, as well as the whole of both internal and external parts of the nose, is commonly such as to tax both the skill and the ingenuity of the surgeon who is required to repair the damage sustained by the loss of the parts, to remove the disfigurement produced by the destructive disease, or by violence, or, it may be added, to remedy the deformities of congenital malformation. Fortunately, however, the results obtained by operation within the last half century in such cases, are among the most satisfactory achievements of surgery. In extreme cases, where the external nose has been entirely destroyed, the hideous and disfiguring chasm left in the face may be to some extent, in probably all cases, covered in by operation; it can at least be hidden by an artificial organ, even where the natural and necessary framework of cartilage and bone is altogether lost. The modern surgeon does not despair of success in forming at least a sightly if not beautiful nose. Where some portion only of the organ, usually its extreme point, is wanting as the result of accident or disease, or where depressions with loss of substance exist as the result of syphilis, a rhinoplastic operation of some nature is indicated, and is often, by the ingenious methods of modern surgery, rendered a brilliant success. The details of the various methods which are employed in cases of this kind, are fully considered in various surgical works, notably that of Buck,[1] and hardly come within the scope of this article. [See Appendix, page 452, *infra.*]

INJURIES AND DISEASES OF THE FRONTAL SINUS.

Direct violence expended upon the forehead between the eyes, or upon the superciliary projections, may cause either a simple, a compound, or a comminuted fracture of the walls of the frontal sinus.

SIMPLE FRACTURE.—A simple fracture at this point offers a more favorable prospect than fractures of the skull in general, on account of the space which exists between the skull walls ; but such a case should be carefully watched, and a guarded prognosis given, until the exact extent of the lesion is known. In the absence of all cerebral symptoms it is not an important one, and its only unfavorable result may be an emphysematous condition of the scalp, face, and eyelids, which occurs from the escape of air from the nose into the surrounding connective tissue. When the outer table is depressed, it should be elevated to prevent subsequent disfigurement.

COMPOUND AND COMMINUTED FRACTURES are usually the result of gunshot wounds, blows, stabs, or explosions, and may be complicated by the lodgment of a foreign body.[2] The results are more serious, but not necessarily fatal, even when the posterior wall of the sinus is fractured, and the dura mater exposed. The indication of course is at once to remove the foreign body and all loose fragments of bone, to do which it may be necessary to trephine or cut away with bone-forceps a part of the overhanging edges of the cavity, and thus afford space for extraction. Simple antiseptic dressings are then applied, and the wound kept well drained, until cicatrization is complete. As a result of such injuries, fistulous openings may remain through which air passes, and these may require plastic operations for their closure ; or if cicatrization has been complete, but bony defect remain below it, the skin will be swollen out into an elastic, crepitating tumor, whenever the patient blows his nose. (Dupuytren.) The use of a pad and compress will usually, however, effect a cure in these cases, which are rare.

ACUTE INFLAMMATION, with or without resulting *abscess*,[3] is usually due to tertiary syphilis, or to the extension of catarrhal inflammation from the nose, through direct continuity of structure ; it may also follow the use of forcible injections high up into the nasal passage, or the use of the nasal douche. In these latter cases, a continuance of the exciting cause may lead to a chronic inflammation of the sinus (chronic abscess or mucocele) accompanied by a purulent or muco-purulent discharge from the nose, extremely difficult to relieve and often offensive in its character, and may result in permanent distension of the cavity, displacement of the eyeball, if the outlet of the sinus become closed by swelling or by plugging with inspissated mucus or crusts. and deformity of the face. In acute inflammation also, especially if pus be formed, all of the symptoms to which it gives rise are much aggravated if communication between the anterior ethmoidal cells and the nasal passage is cut off by acute swelling of the mucous membrane, so that the secretions, instead of finding a ready exit through the nose, are pent up, causing marked distension of the parts, deformity of the eyeball, and swelling of the upper eyelid. In such a case, if it be not evacuated by artificial means, pus will usually pass into the other sinus by breaking down the septum, or may possibly perforate through the anterior wall, if it cannot find its way out by the nose, which is the most favorable direction. The possibility also must always be borne in mind, that an acute abscess may make its way into the cranial cavity through the posterior wall of the sinus, or, if the orbit be involved, through the optic foramen, and that the brain may thus become implicated, especially in tertiary syphilis.[1] Bizet[2] reports such a case of perforation from syphilitic abscess, in which there was a hernia of the Schneiderian membrane, through the aperture.

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[1] Reparative Surgery. New York, 1876.

[2] For a number of interesting examples, see Watson, Diseases of the Nose, p. 129, and appendix.

[3] See Hartman on Empyema of the Frontal Sinus. Deutsch. Archiv für klin. Med., 1877, S. 531

The *symptoms* of acute inflammation and of abscess are usually marked: pain, weight and fulness over the forehead, headache, and all the local symptoms of an acute coryza, are early complained of. The formation of an abscess is indicated by an accession of the local swelling and an increase in the local suffering, high febrile disturbance, excessive headache, rigors, and delirium; even semi-coma may result, and perhaps paralysis of the limbs of the opposite side, showing the course taken by the pus. (Watson.) An erysipelatous blush appearing upon the surface is regarded by many authors as an almost unerring sign of the nature of the disease.

Treatment by leeching over the affected sinus early in the acute form of the disease, may abort it; if it fail, pus form, and the case become urgent, as shown by the cerebral disturbance and excessive local inflammation, an attempt may be first made to establish a communication with the cavity of the sinus through the nose, and thus draw off the accumulated matter, by passing a stout probe up through the natural channel with some force; if this fail, an incision is made, directly through the swollen tissues down to the bone, and a small trephine is then used, to make an opening into the most dependent part of the sinus. If there be no evidence of swelling or pointing at any one place, the instrument should be applied at the upper and inner angle of the orbit. The opening made, the cavity may be washed out with warm, disinfectant, astringent, anodyne, or detergent solutions, and a drainage tube inserted. If necrosed bone be present, as in syphilis, it must be carefully removed; much relief may be given, also, by the use of various sedative ointments applied to the nasal mucous membrane, by means of a probe wrapped with cotton. Cohen recommends one of stramonium, or simple cerate in which a few grains of morphine to the ounce have been well incorporated. Chronic abscess, or mucocele, in its early stage, resembles very closely a bony tumor; if it has lasted any length of time, it usually causes either an absorption of the expanded portion of bone over it, or renders this so thin that it is readily compressible; an exploratory puncture is thus easily made into the tumor, and its true nature established; a direct incision will now serve to free it of its contents, and attempts must then be made to establish, either by the natural way or by an artificial puncture, communication with the nasal passage; and this must be kept open by means of a drainage tube, until its permanency has been established.

DROPSY OF THE FRONTAL SINUS, cases of which have been reported, is probably of the same nature as mucocele, and requires the same treatment.

TUMORS OF THE FRONTAL SINUS.—*Cystic growths*, which are more frequently found than tumors of any other variety, may be serous, hydatid, or steatomatous in their nature; they may occur at any age, or even be congenital;

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[1] Richter, Observat. chir. Fasc. ii.

[2] Gaz. Méd. de Paris, p. 663. 1863.

of the hydatid and steatomatous varieties, cases are reported by Langenbeck[1] and Brunn, in addition to several instances collected by Demarquay.[2] The diagnosis is necessarily obscure, until the growth of the cyst, which resembles a chronic abscess in its development, has so thinned the anterior wall of the frontal sinus that fluctuation can be detected, and an exploratory puncture made. The contents of the cyst may then be evacuated, and its sac either excised or stimulated to contraction by the use of an injection of iodine or some astringent wash, or it may be pierced through into the nasal passages, for the establishment of thorough drainage, as in chronic abscess.

Myxomatous or gelatinous polypi may either be developed within the frontal sinus, or extend into it from the nose, causing by their growth, in either case, deformity, attenuation of the bony walls, and pain. They are commonly single, but may be multiple. Seven examples of polypi of all descriptions—including the *fibrous* variety, which is very rare, but which may by its rapid growth extend into all the neighboring cavities, even that of the cranium—are reported by Demarquay; and additional cases of interest may be found detailed by Watson[3] and Leveret.[4] Viallet and Rouger report a case in which a polypus was associated with an exostosis of the cavity. The diagnosis having been established, the removal of the growth is effected by either the knife or the gouge, after the trephine and a crucial incision through the skin have given direct access to it.

Osteomata,[5] curiously enough, have a peculiar preference for this region of the body, but constitute a very rare variety of tumor. Composed either of cancellated tissue, or of a compact tissue which renders the growth hard, ivory-like, or eburnated, and developed in the diploë of the frontal bone, they may attain a considerable size and occasion much distortion of the parts. Diagnosis as to their nature is not always easy. Attention has already been called to the fact that the tendency of all affections of the frontal sinus is, in the first instance, to cause distension of its bony walls, and thus to simulate very closely a bony tumor. The slow progress, unyielding hardness, and absence of inflammatory symptoms in true bony growths, will serve, in a short time, however, to render their true character plain. Occasionally, when small, they may readily be extirpated through an external incision made into the anterior wall of the orbit, or into the sinus; but the fact that they often extend backwards as well as forwards, even into the cranial fossæ, involving both bones and membranes, will render the surgeon cautious in undertaking operative interference which may be both difficult and dangerous. In many, perhaps a majority, of cases, if we may judge from those recorded, an operation is out of the question.

Malignant disease of a *sarcomatous* character, is, according to Gross, more common than is generally imagined. *Epithelioma*, when found in the frontal sinus, will usually have extended from some of the adjacent structures. Of *scirrhous*, *colloid* and *melanotic cancer* of the sinus, we possess no examples recorded in literature.

The development of any of the varieties of tumor here enumerated is attended by certain characteristic appearances; the external distortion in the configuration of the frontal sinus and its adjacent parts, often to such an extent as to produce the most hideous deformity, has already been alluded to, while absorption of the bony walls by the continued pressure, displacement of the eyeball outwards or downwards, distortion of the nose and of various other parts of the face, œdema and tumefaction of all the tissues, impaired vision, epistaxis, profuse discharge from the nasal passages, and intense headache—readily mistaken in the earlier stages for the manifestations of a cachectic or syphilitic cephalalgia—with compression and ultimate perforation of the bony structures at the base of the skull, and involvement of the anterior lobe of the cerebrum, with serious cerebral disturbance, are, unfortunately, but common results.

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[1] Mackenzie, Diseases of the Eye, p. 16.

[2] Tumeurs de l'Orbite, p. 95.

[3] Op. cit., p. 139.

[4] Observations sur la Cure de plusieurs Polypes, p. 235. Paris, 1749.

[5] See Boenhaupt (Case of osteoma of the left frontal sinus, with remarks on osteotomata developing in the accessory cavities of the nose), Arch. für klin. Chir., Bd. xxvi. S. 589. 1881.

Foreign Bodies in the Frontal Sinuses.—The entrance and lodgment of foreign bodies in these cavities, as the result of gunshot wounds or other injuries, have been referred to. Reference must now be made to the presence of living insects, flies and worms, which either crawl up from the nasal fossæ, or are developed from ova, deposited directly within the sinuses or introduced in the act of smelling certain flowers or fruits upon which they have been placed by the insect. (Saltzman.) Fatal disease from such causes is said to be not rare in some countries, notably in India, where it is called Peenash.[1] The symptoms of their presence are well marked, and consist in continuous or intermittent headache, located over the frontal sinus, cerebral excitement and maniacal delirium, fainting, sudden vertigo and even sudden and temporary blindness, a profuse muco-purulent or fetid discharge, and epistaxis. (Pozzi, Schneider.) In the further course of the affection the bones become necrosed, the eyeball is invaded, the soft parts become gangrenous, and the mouth, gums, and superior maxilla are attacked, and perhaps denuded—the latter conditions, however, only occurring in extreme cases. The diagnosis is confessedly difficult, unless there be a clear history of the entrance of the insect, or some evidence of its life, in the discharges from the nose. To dislodge these insects, various expedients are recommended. Vapors of carbolic acid, sulphur, or iodine, forced into the cavities by means of compressed air, one nasal passage being held closed, and injections of saline solutions, or of those containing permanganate of potassium or carbolic acid, have all answered a good purpose. The inhalation of chloroform may be tried, or the insufflation of irritant snuffs may, by exciting the act of sneezing, be sufficient to cause their dislodgment. In extreme cases, the sinus must be trephined, to afford direct access to its interior. (Kohts.)

Foreign bodies may be formed within the frontal sinus: thus Bartholinus details instances in which he has seen, in the sinuses, earthy concretions similar to those which are sometimes found in the nose. Their treatment, if they give rise to any irritation, would be that of any other foreign body in this locality.

Diseases of the Ethmoidal Cells.

Owing to the direct continuity of the mucous membrane of the nose with that lining the cells of the sphenoid bone, all those processes which affect the former may likewise exert their influence upon the latter. Catarrhal inflammations, inflammatory thickenings, polypoid excrescences, and even, according to Virchow, osteitis and caries, with perforation of the base of the skull, may thus find their seat within the walls of this cavity. Diphtheritic ulceration of its mucous membrane has been reported. Chronic inflammation of the cells is, if we may credit Michel, the most frequent cause of so-called ozæna.

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[1] See Med. Times and Gazette, January 30 and February 6, 1875, and Indian Med. Gaz., August 18, 1874.

Diseases of the Antrum of Highmore.

The mucous membrane which lines the interior of the cavity of the antrum, being but a direct continuation of the nasal or Schneiderian membrane, is liable, though not to the same degree as the latter, to develop inflammatory conditions, which are the result of a direct extension of the process by continuity of tissue from the nasal passage, and the converse is likewise true.[1] In many cases, the primary evidences of the antral affection may be detected in the nasal passage, by means of an anterior or posterior rhinoscopic examination; and as the resulting inflammation, swelling, and displacement of the nasal parts may be great in either case, and well calculated to deceive, a brief consideration of the commoner diseases of the antrum which occur in connection with those of the nose, is desirable at this point.

Inflammation and abscess are the affections most frequently met with. Any extension of a severe catarrhal, syphilitic, or, more rarely, herpetic or variolous inflammation of the nasal mucous membrane, is an efficient factor in producing a like condition of that of the antrum—one which varies both in its degree, extension, and rapidity of development, as well as in the amount and character of the attendant secretion, which may be either mucous or muco-purulent. Salter has called attention to the peculiar circumstance which here gives importance to this altered and more abundant secretion, and to the disease; viz., that it may be confined within the sinus by means of the swelling and turgescence of the mucous membrane around its orifice, and that thus, from a mere anatomical arrangement, a catarrhal inflammation, spending itself by superficial suppuration, may lead to the formation of a shut, expanding sac, in many respects equivalent to a deep-seated abscess, though by no means identical with that condition either in pathological history or absolute anatomy. Aside from the above causes, affections of the teeth—dental caries, or alveolar abscess, in some stage, associated with disease of the teeth—are by far the commonest factors in the production of the disease. The peculiar anatomical relation which the antrum bears to the teeth is well known; it varies greatly, as regards both the extension of the antrum over the fangs of many or few teeth, and the degree in which these fangs approach or pierce the floor of the sinus. (Salter.) Other causes only occasionally exist; thus a blow upon the cheek has been known to excite acute inflammation within the antrum, and it has developed in the infant from injuries received during labor.[2] A case of abscess depending upon the presence of polypi within the antrum, is reported by Watson. Another, in which the cause was a bony tumor lying loose within the cavity, will be found in the Edinburgh Medical Review, October, 1867; and, finally, necrosis of the alveolar ridge, the presence of a tooth thrust into the cavity in endeavoring to extract it, and that of various other foreign bodies, introduced by violence, may all act as exciting causes of inflammation and suppuration.[3] The tendency of the inflammatory process arising from any of these causes, to extend to or involve the nasal passage, has been alluded to. The physical signs of inflammation and pus-formation in the cavity of the antrum, vary necessarily in degree, and differ according to the exciting cause. Much depends, in regard to their severity, upon whether there be an outlet for the discharge of the pus, either through the natural opening of the cavity into the nasal passage, or, in rarer instances, through the socket of some tooth that has been removed, or fistulous passage that has been made; or whether, no ready outlet presenting itself, and the natural one being closed by the swelling of the tissues about it, the pus is pent up, a confined abscess resulting. In the first class of cases, the only indication that the process of suppuration is proceeding within the antrum, aside from the probably inflamed and swollen appearance of the nasal passage, may be the occasional discharge of quantities of offensive pus into the nose—especially when the head is held in certain positions—and the ozænic smell; and the cause will be found, in many cases, as has been stated, to be a decayed tooth, one fang of which, perhaps, protrudes through the floor of the cavity. An examination with the nasal speculum may disclose the fact that pus trickles into the middle meatus of the nose, and the diagnosis is thus confirmed. If a decayed and tender tooth be determined upon as the cause, it may be extracted; and through the passage thus made, and enlarged, if necessary, by means of a drill, the cavity of the antrum may be thoroughly washed out with disinfectant solutions. This will, in all probability, be all that is necessary to effect a cure. Should, however, discharge persist, a thorough exploration of the whole antrum, with scoop and probe, must be made through the perforation, in order to detect the foreign body, necrosed bone, fragment of tooth, or the like, which lies at the root of the matter and keeps up the discharge.

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[1] Wolfram (On the treatment of catarrh of the antrum), Berlin klin. Wochenschr., No. 6. 1879.

[2] Druitt, Surgeon's Vade Mecum, p. 431.

[3] See, also, Weichselbaum (On phlegmonous inflammation of the accessory cavities of the nose), Med. Jahrbuch, Heft. ii. 1881.

If, on the other hand, the matter is confined within the antrum—if abscess, in other words, result—the symptoms are marked and painful. As a class, these do not vary from the symptoms attendant upon like collections of matter within resistant walls in other parts of the body, though certain signs are, in this instance, incident to its particular locality. Thus, the expansion of the whole jaw; the elevation of the malar bone, with its fossa full and prominent; the apparent elongation of the molar teeth upon the affected side; the convexity of the normally concave hard palate; and the swelling of all the soft parts of the nasal passage, as shown in both anterior and posterior rhinoscopic examination, bespeak beyond doubt the true nature and exact situation of the disease. If relief be delayed, the eyeball may be displaced, and amaurosis—consequent upon periosteal inflammation extending into the orbit and involving the sheath of the optic nerve—may occur. The ultimate result, if nature be unaided by the surgeon, will vary much. Occasionally the abscess bursts into the nose, or the pus finds its way out, by burrowing alongside the fang of some tooth, into the mouth. More rarely it perforates the cheek or the floor of the orbit, and passes into the lower eyelid. Before, however, these latter accidents happen, fluctuation will usually be distinctly perceptible at some point upon the anterior surface, or in the hard palate, and the appropriate means of relief will be thereby suggested. If doubt still exist—if some portion of the bony walls be not so thin but that it yields on pressure, and gives to the finger the sensation of dry, tightly-stretched parchment—the use of a small trocar will serve to draw off enough fluid, usually no thicker than ordinary pus, and sometimes serous, to ascertain the nature of the swelling; and can do no injury to a solid growth if such be the true character of the expansion. Diagnosis is only difficult where the distension of the sinus goes on for years, as it sometimes does, slowly and painlessly, and with so little local disturbance that the idea of an abscess is not suggested; and in those rare instances in which abscess is complicated by the presence of a tumor within the antrum. Both classes of cases, and the errors in treatment to which a faulty diagnosis may lead, are illustrated by instances in Watson's work,[1] and are alluded to by other authors.

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[1] Op. cit., p. 162.

Treatment.—Before the abscess has formed, when it is as yet only imminent, the inflammatory process may probably be arrested by removing some carious or tender tooth, which a skilful dental examination has shown to be its probable exciting cause. The first permanent molar, as a rule, is the one indicated, though the removal of several teeth may be necessary. When pus has already accumulated and no outlet exists, a free opening for its evacuation becomes necessary, and the method consists in the removal of a tooth and the perforation of the antrum at its base. Hunter[1] long since clearly sketched out this and the other surgical steps required:—"The first part of the cure, as well as that of all other abscesses, is to make an opening, but not in the part where it threatens to point, for that would generally be through the skin of the cheek. If the disease is known early, before it has caused the destruction of the fore part of the bone, there are two ways of opening the abscess: one by perforating the partition between the antrum and the nose, which may be done; and the other by drawing the first or second grinder of that side, and perforating the partition between the roots of the alveolar process and the antrum, so that the matter may be discharged for the future that way. But if the fore part of the bone has been destroyed, an opening may be made on the inside of the lip, where the abscess most probably will be felt; but this will be more apt than the other perforation to heal, and thereby may occasion a new accumulation, which is to be avoided if possible by putting in practice all the common methods of preventing openings from healing or closing up; but this practice will rather prove troublesome, therefore the drawing of the tooth is to be preferred because it is not so liable to this objection."

The opening having been made as thus described, it will usually need to be enlarged by the careful use of a large trocar, and the floor of the antrum may then be broken up sufficiently to afford a free opening for the discharge of the pus. A careful examination with the probe will now have to be made to detect the possible presence of any foreign substance, or of necrosed bone, and, if such be discovered, it must be removed, even, if necessary, by still further enlarging the opening. In conducting this examination, the thoroughness of which is important, the fact that the cavity of the antrum is occasionally divided by partial septa of bone projecting from its walls, as shown by Giraldès,[2] must not be forgotten, for in such an instance a foreign body might lie concealed in some circumscribed region of the sinus, and could only be removed by a curved scoop and by breaking down the partitions. The subsequent treatment will consist in securing thorough cleanliness by the daily free use of disinfectant and stimulating solutions—carbolic acid, permanganate of potassium, sulphate of zinc, alum, nitrate of silver (gr. ij–℥j) and the like—until the discharge becomes healthy in its character, and loses its fetid smell. The opening made may be kept patent by the use of a silver or leaden style, secured in position by fastening it with wire to the neighboring teeth; or a small silver drainage tube may be used, secured in the same way. Salter has contrived an ingenious apparatus to effect the same purpose.[3]

A few points remain to be considered. Should it for any reason be desirable or necessary to open into the antrum at some point other than through the alveolar ridge, experience has shown that it is preferable to do so at the lower part of the canine fossa, the trocar being directed backwards and a little outwards. In cases where, on account of the swelling of the parts, the patient's mouth cannot be opened sufficiently to allow of the extraction of a tooth and perforation of the alveolar ridge, the opening may best be made through the canine fossa, as in the former instance, for the sake of temporary relief, and when the acute symptoms have passed off, the operation may be completed by perforating in the usual way through a tooth cavity into the antrum. The latter operation again is indicated in those instances, rare though they be, where a troublesome, fistulous opening remains as the result of the perforation of an abscess through the cheek or lower eyelid. Enlargement of the sinus, for the purposes of drainage, cannot be undertaken for fear of increasing rather than diminishing the deformity, and its locality prevents its serving the same purpose as a more dependent opening, which should in all instances be made to secure thorough drainage.

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[1] Practical Treatise on Diseases of the Teeth. London, 1771.

[2] Des Maladies du Sinus maxillaire. Paris, 1851.

[3] Holmes's System of Surgery, 3d ed., vol. ii. p. 468.

EFFUSIONS OF BLOOD may occasionally occur in the antrum, either as the result of direct violence, or in consequence of nasal hemorrhage, the blood passing into the antrum through the nasal opening. Suppuration may thus be caused. The *treatment* would be that of ordinary abscess of the antrum.

TUMORS.—Morbid growths of varied nature are extremely liable to originate within the antrum, or less frequently from the alveolar border of the superior maxilla, and involve, in their too often rapid and destructive course, not only the whole cavity of the antrum, but, by gradual extension and breaking down of the thin bony partitions, the cavities of both nose and orbit; the resultant displacement and deformity are excessive. Weber, in a careful and instructive study of 307 cases of tumor of the antrum, has shown their relative frequency to be as follows: carcinoma, 133; sarcoma, 84; osteoma, 32; cystoma, 20; fibroma, 17; enchondroma, 8; gelatinoid polypus, 7; melanotic sarcoma and carcinoma, 5; and, finally, angeioma, 1; but he remarks that carcinoma occurs too frequently in the list, doubtless from its having been frequently confounded with medullary sarcoma. He believes that the latter embraces rather more than one-third, and carcinoma less than one-third, of all morbid growths of the superior maxillary bone.

These tumors, their differential diagnosis, and the operations necessary for their removal, are fully considered in other articles.

DISEASES OF THE SKIN AND SUBCUTANEOUS TISSUES OF THE NOSE.

A number and variety of affections may develop primarily in the integument covering the nasal organ, or may involve it by a process of extension from neighboring parts; of these the commonest are herpes, acne, eczema, nævus, syphilis, lupus, and epithelioma; more rarely, rhino-scleroma and malignant pustule. Gangrene and frost-bite also may claim the attention of the surgeon. These affections are elsewhere considered.[1]

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[1] See Vol. I., page 228, and Vol. II., pages 253, 293, 610 *et seq.*

Note to page 375.—Several very valuable contributions to our knowledge of the pathology of hay fever, which the reader should by all means consult, are the following: J. O. Roe, The Pathology and Radical Cure of Hay Fever or Hay Asthma (New York Med. Journal, May 3, 1884); Ibid., May 12 and 19, 1883; Harrison Allen, Amer. Journ. Med. Sciences, Jan. 1884; C. E. Sajous, Hay Fever and its Successful Treatment (Trans. Amer. Laryngological Association, 1884. Abstract, with discussion and remarks by Drs. Shurly, Bosworth, Mackenzie, Robinson, and Johnson, Medical News, May 24, 1884). The reader should consult also Hack, Ueber eine operative Radical-behandlung bestimmter Formen von Migräne, Asthma, Heufieber, sowie zahlreicher verwandter Erscheinungen. Wiesbaden, 1884. These contributions to the subject of hay fever have appeared since the above article was written. They throw much new light upon the obscure and disputed question of causation, and should certainly be read in connection with what is said in the text.

[APPENDIX.

Rhinoplastic Operations.

(*By the Editor.*)

Rhinoplastic operations, or operations designed to accomplish the partial or complete restoration of a nose, may be required to correct a congenital deformity, to remedy the effects of injury, or to repair the ravages occasioned by ulceration, with or without necrosis or caries, by lupus, by constitutional syphilis, etc. It is an invariable rule in nasal surgery that no operation of this kind shall be undertaken until the process of destruction by which it is rendered necessary has been entirely and definitively checked.

Rhinoplastic operations may be divided into those designed to repair a nose which has been only partially lost, and those intended to remedy complete destruction of the organ.

I. Operations for Partial Restoration of the Nose.

Repair of Columna and Septum.—Should the loss of tissue be limited to the *columna nasi* and *septum*, a new columna may be conveniently formed from the upper lip, by making an incision on either side of the median line, and through the whole thickness of the part, thus separating a portion about one-third of an inch in width, and of a length equal to the depth of the lip; this strip is then turned upwards, and its end, having been suitably trimmed, is adapted to the tip of the nose, which must be freshened for the purpose, and is secured in its new position by the twisted or shotted suture. The labial mucous membrane which is thus turned outwards, gradually loses its normal character and becomes assimilated to skin. The sides of the lip are approximated with harelip pins and interrupted sutures, and a few narrow strips of plaster are so adjusted as to support the transplanted portion until it becomes firmly adherent in its new position. The dimensions of the newly-made nostrils must be maintained by occasionally introducing into each a silver or gutta-percha tube.

Deficiency of one of the alæ may be repaired, if the loss of tissue be but slight, by taking a flap from the upper part of the nose itself, and attaching it with numerous points of the interrupted suture to the previously freshened edges of the gap. If the deficiency be greater, it will be necessary to take a flap from the cheek or forehead, the former plan being, I think, the better. The cheek-tissues are very vascular, and a flap large enough to replace almost half the nose can be readily obtained, and by curving the ends of the incisions can be slid into place, without any necessity of twisting the pedicle upon itself, as must be done when the flap is taken from the forehead. If the latter plan be adopted, to prevent sloughing of the pedicle, a groove should be cut on the dorsum of the nose for its reception. When union is completed, the pedicle may be raised and cut away, and the groove then closed again with sutures.

UNDUE SHORTNESS OF THE NOSE is sometimes the source of much annoyance, and may be remedied by the plan adopted by Prof. Weir, of New York, which consists in cutting across the nose in a transverse direction, drawing down the tip to the desired position, and filling the wedge-shaped gap which results by transplanting flaps from the cheeks.

Should the patient seek relief on account of the opposite condition—too great *length of nose*—it would probably be sufficient to remove a transverse wedge from the elongated tip of the organ, and close the wound with sutures.

OPERATION FOR DEPRESSED NOSE.—Disease of the nasal bones and cartilages may cause the organ to have a flat and sunken appearance, without there being any external ulceration. The late Sir William Fergusson, in a case of this kind, succeeded in remedying the deformity by a modification of the procedure originally suggested by Dieffenbach. Introducing a narrow knife within the nostrils, he separated the soft tissues from the underlying bones, and then brought the whole nose forward by passing long, steel-pointed, silver needles through its base from cheek to cheek, and then twisting them over strips of perforated leather. A new columna was afterwards formed in the ordinary manner.

FISTULOUS OPENINGS through the bones of the nose are occasionally met with, as the result of necrosis following scarlet fever, etc. The treatment consists in freshening the edges of the orifice, and adapting a flap taken from either cheek or forehead as may be found most convenient.

II. OPERATIONS FOR RESTORATION OF THE WHOLE NOSE.

Several methods are employed for restoring the entire nose, when this is necessary, those which are best known being respectively called the *Taliacotian* and the *Indian* operation.

THE TALIACOTIAN METHOD has received its name from Tagliacozzi, or Taliacotius, an eminent Italian surgeon of the sixteenth century, who published an account of his operation, with numerous illustrations, in 1597.[1] It is perhaps hardly necessary to say that the popular notion that Taliacotius fashioned noses for his patients from the nates of persons hired for the purpose, is unfounded, and appears to have originated in the fertile imagination of the Author of Hudibras. The part from which the Taliacotian nose was really derived, was the upper, and usually the left, arm of the patient himself. A flap of skin and connective tissue of sufficient size is, in this operation, first marked out on the upper arm and partially detached, and is left in this condition for about two weeks, in order that it may become vascular and thickened by the process of granulation. At the end of this time the stump of the original nose is pared, and the flap then reduced to proper shape, and attached by numerous stitches in its intended position, the arm being brought up to the head and fixed by a complicated arrangement of slings and bandages. After about ten days more, when the new nose is supposed to be firmly adherent, its connections with the arm are severed, and any needful trimming of the new organ is effected. Finally a columna is made from the upper lip.

This operation has been varied by Warren and others, by taking the flap from the forearm, and by diminishing the time during which the head and arm are kept in contact; but even with these modifications, it is so tedious and irksome that it is seldom employed at the present day, though it has been occasionally adopted, and with success, as by Sir William MacCormac, and by Dr. Stokes, of Dublin. In order to provide a bony support for the new nose, Dr. Hardie, of Manchester, in the case of a young girl, transplanted the ungual phalanx of one of her fingers, keeping his patient's arm fastened up to her face for no less than *three months.*

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[1] De Curtorum Chirurgia per Insitionem Libri Duo. Venetiis, 1597.

THE INDIAN METHOD, which is that now commonly adopted, was introduced into England by Mr. Carpue, in 1816.[1] By this method the nose is made from a flap taken from the forehead, supplemented if necessary by a columna derived from the upper lip. As ordinarily performed, the operation may be divided into three stages.

In the *first stage*, a flap of proper size and shape is cut from the skin of the forehead, and attached in the position which it is meant to occupy. A piece of thin gutta-percha or card-board is first modelled to the form and dimensions of the wished-for organ, and is then flattened out and laid upon the forehead as a guide for the future incisions. The flap may be taken from the centre of the forehead, or from either side, as may be thought most convenient. As the flap is sure to shrink after it is detached, it is a good rule to allow a margin of one-fourth of an inch on all sides of the pattern, and the lines of incision should be carefully marked with a dark crayon, or with tincture of iodine.

The error is sometimes committed of making the flap needlessly large, and I have known of cases in which the new nose has by its prodigious bulk been a source of quite as much mortification to the patient as his previous lack. Hence the importance of carefully outlining the form of the needed part, and of not allowing more than the quarter-inch margin which has been directed. Should the patient have an unusually high forehead, the central portion of the flap may be prolonged in order to furnish a columna, but under other circumstances this part of the operation is better left for a subsequent occasion. I may add that Prof. Bennett, of Dublin, advises against the formation of a columna altogether, finding that the contraction of the deep surface of the flap leaves an orifice none too large for the admission of air, and that the overhanging of the middle lobe of the flap prevents any deformity.

In raising the frontal flap the incision is begun at the root, which is made long, so that its circulation may not be interfered with when it is twisted; the incision is usually prolonged further on one side than on the other, so that the root may be twisted more readily. All the soft tissues of the forehead should be embraced in the flap, and it has even been recommended that the periosteum should be likewise included, in hope that by its osteogenetic power bone might be developed in the transplanted tissue. Such a result, however, would not be very likely to ensue, nor, if it did occur, would it be of much benefit to the patient, while by depriving the frontal bone of its periosteum, some risk is entailed of necrosis. When the flap has been formed, it is temporarily replaced over a piece of wet lint, while the stump of the old nose is prepared for its reception. This is done by freshening its edges, dissecting up the skin in such a way as to make a groove to receive the flap, which should itself have its edges bevelled so as to provide two raw surfaces. All bleeding having been arrested—if possible without using any ligatures—the flap is lightly twisted upon its root and adjusted in its new position, being secured with numerous points of the interrupted or shotted suture, or with the ingenious "tongue-and-groove suture" recommended for the purpose by the late Prof. Joseph Pancoast, of Philadelphia, who had great success in rhinoplastic operations. The flap should be supported by gently introducing below it a plug of oiled lint, or two small plugs, one on either side of the columna, if there be one, and a fold of oiled lint may be lightly laid over the part, to assist in preserving its temperature. The wound on the forehead may be partly closed with harelip pins and adhesive strips, but must be mostly left to heal by granulation. The patient, after the operation, should be put to bed in a warm room; the dressings should not be disturbed for several days, when it will probably be necessary to remove the plug and introduce a new one; the sutures should remain until firm union has taken place.

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[1] Account of Operations for restoring a Lost Nose from the Integuments of the Forehead, etc. London, 1816.

The *second stage* of the Indian method consists in forming a columna from the upper lip, if one has not already been made from the forehead. This may be done, in the way heretofore described, either at the time of, or two or three weeks after, the former operation. As has been mentioned, Prof. Bennett thinks it better to dispense with the columna altogether.

The *third and final stage* consists in separating the root of the frontal flap, which should not be done until at least a month after the first operation. A narrow bistoury is thrust beneath the pedicle, and made to cut its way upwards, removing a wedge-shaped portion so as to give a smooth bridge to the nose; or Fergusson's plan may be adopted, the root of the new nose itself being cut into a wedge, and laid into a groove made for it in the forehead.

The size of the opening or openings left for the admission of air, must be maintained by the patient's wearing, for several months, a tube or tubes of silver or gutta-percha. The results of the Indian operation are commonly quite satisfactory, though failure may ensue from the flap sloughing, or from a recurrence of the disease which rendered the operation necessary. In one of Liston's cases, secondary hemorrhage followed on the ninth day, and death even has resulted, in the practice of a no less distinguished operator than Dieffenbach.

SYME'S METHOD.—This mode of operating, which was introduced by the late Prof. Syme, of Edinburgh, aims to utilize the tissues of the cheeks, from which flaps are taken, and united in the median line by sutures, while their outer edges are attached to raw surfaces which have been previously prepared at a suitable distance from the nostrils. The nose made by this method is apt to be rather flat, to prevent which it might be well to keep it pressed forward, until the occurrence of union, by fastening the sides together with steel-pointed silver needles, in the way already described in speaking of the treatment of depressed nose.

WOOD'S METHOD.—Prof. John Wood, of King's College, London, following in the same lines as in his ingenious operation for extroverted bladder, employs an inverted flap, taken from the upper lip and elongated by separating its mucous from its cutaneous surface, from the root of the flap to, but not through, its free border, and then covers this with lateral flaps derived from the cheeks.

OLLIER'S METHOD.—Prof. Ollier, of Lyons, likewise employs an inverted flap, but taken from the forehead and made to include the periosteum, and covers it with side flaps taken by preference from the stump of the nose.

Finally, I feel bound to say that, in some cases, it may be better not to attempt any rhinoplastic operation, but to be satisfied with the adaptation of an artificial nose, which may be supported by a spectacle-frame, and kept in place by the pressure of a light spring within the nostrils. The best material for the manufacture of artificial noses, is said by Prof. N. W. Kingsley, of New York, who has been quite successful in this branch of prothetic surgery, to be the substance which is known to dentists as "rose pearl," and which is, I believe, a preparation of collodion.]

INJURIES AND DISEASES OF THE FACE, CHEEKS, AND LIPS.

BY

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Wounds of the Cheeks.

THESE are often attended with considerable hemorrhage, from division of branches of the facial and transverse facial arteries. There is, for the most part, no difficulty in securing these vessels by torsion or by ligature. When the wounds are deep and extensive, they should be accurately closed by fine sutures, as in this situation agglutinative plasters are entirely unreliable. When the wound involves the duct of Steno, there is danger that it will be followed by salivary fistula. This is to be guarded against by extending the wound freely into the buccal cavity, and by special care in the accurate adjustment of the edges of the divided skin. When the facial nerve or its branches are divided, the muscles to which they are distributed will be paralyzed. It is important, in such cases, that the divided ends of the nerve should be brought in contact, and secured by fine sutures. If a twig of the trifacial nerve should be included between the edges of the wound, it may become the seat of neuralgic pains, and in such cases the affected portion of the cicatrix should be excised.

BADLY LACERATED OR CONTUSED WOUNDS, AND GUNSHOT WOUNDS, of the face, may lead to sloughing with considerable loss of substance, followed by cicatricial contractions which distort the features and cause morbid adhesions of the lips and cheeks to the jaw-bones. Great care should be taken, during the treatment of such wounds, to guard against these distortions and adhesions. In many cases, these unpleasant effects cannot be altogether prevented, but in most instances they may be subsequently remedied, in part at least, by plastic operations. The face is often much disfigured by a deeply depressed cicatrix, occasioned by adhesion of the skin to the periosteum or bone. I have succeeded in relieving this disfigurement by the very ingenious operation introduced by Mr. Wm. Adams, of London.[1] This operation consists in the free subcutaneous division of the constricting band, followed by the elevation of the cicatrix above the level of the surrounding integument, this position being maintained for three days by means of two harelip pins crossing each other at right angles.

POISONED WOUNDS of the face are not uncommon, such as are inflicted by the stings of bees, wasps, and hornets, and by the bites of spiders. The burning heat and pain, and the other inflammatory symptoms, are promptly relieved by the application of a strong solution of bicarbonate of sodium.

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[1] British Med. Journal, April 29, 1876.

Severe inflammatory swellings of the face are also occasioned by contact with poison-ivy. Among the remedies which have been highly recommended for the relief of these symptoms are saturated solutions of sulphite and hyposulphite of sodium; liquor sodæ chlorinatæ of full strength, or diluted with from three to six parts of water; and bromine dissolved in olive oil, gtt. x–xx to f℥j.[1]

FACIAL PARALYSIS.

The facial nerve may be paralyzed in consequence of a wound dividing its trunk, or from pressure in any part of its course, within or without the cranium. Paralysis may result from exposure to a draft of cold air, and from other causes, some of which are quite obscure. The face is drawn towards the opposite side, the mouth cannot be perfectly closed, the eyelids of the affected side remain widely open, and the eyeball is exposed to injury. When the paralysis is the result of division of the nerve, the divided ends may be united by suture. When it occurs from other causes, benefit may sometimes be derived from the use of electricity, and from the administration of strychnia, either by the mouth or hypodermically.

SALIVARY FISTULA.

This may be the result of wounds, burns, or sloughing or phagedenic ulceration, involving the duct of Steno. The outflow of saliva is an occasion of much annoyance to the patient, and it sometimes taxes the ingenuity of the surgeon to effect a cure. The main indication for treatment is to establish a free communication between the duct and the interior of the buccal cavity, and to close the external orifice of the fistula. This object may sometimes be accomplished by introducing a seton or tent through the fistula into the cavity of the mouth, and wearing it until a sufficiently large internal orifice has become established, and then closing the external orifice, either by the application of the actual cautery or by paring its edges and drawing them together with sutures. In obstinate cases, after establishing the internal opening, the external orifice may be closed by a plastic operation.

Desault gives minute directions for the cure of salivary fistula by seton.[2]

In cases of unusual difficulty, the fistulous orifice, with the portion of the duct communicating with it, may be dissected from the surrounding parts and introverted into the cavity of the mouth, where it may be fixed with silver wire sutures. Operations of this kind have been performed by Langenbeck, Van Buren, J. R. Wood, and Erskine Mason.[3] Dr. H. H. Smith, in his work on Operative Surgery, describes an operation devised by the late Dr. Horner, who punched a hole through the cheek, making a free opening into the buccal cavity, and then closed the external wound.

Rodolfi succeeded in closing a salivary fistula by painting the surface with collodion.[4]

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[1] See Med. Record, July 12, 1879, p. 46; Aug. 2, p. 117; Sept. 20, p. 284; Apr. 20, 1878, p. 320; and July 1, 1873, p. 313.

[2] Œuvres Chirurgicales de Desault, par Bichat, tome ii. p. 221.

[3] See Med. Record, Aug. 7, 1880, p. 163.

[4] Gazz. Med. Ital. Lombard., t. iii. 1854.

FACIAL NEURALGIA OR TIC DOULOUREUX.

This is an exceedingly painful affection of the nerves of the face, chiefly affecting the branches of the fifth pair. It may be the result of traumatic lesions, or it may occur from malarial exposure, or from a variety of constitutional or local causes. Its most common cause is direct irritation of the dental nerves, but it may be the result of reflex irritation originating in parts more or less remote. The pain often occurs in paroxysms of frightful severity, aggravated even by the slightest touch or motion of the affected parts. During the intervals between the paroxysms, the remissions are often quite incomplete, and the sufferings of the patient are so severe and persistent, as to render life an almost intolerable burden.

Treatment.—Special attention should be paid to the causal indication. When the neuralgic pains are the result of reflex irritation, the primary cause should be carefully investigated, and appropriate remedies should be employed to remove it, or to counteract its agency.

When the neuralgia is the result of direct irritation of the branches of the fifth pair of nerves, relief may sometimes be afforded by powerful revulsion, as by the application of the moxa or the actual cautery. Bartholow cured several cases by injecting chloroform deeply into the tissues in the vicinity of the nerve involved in the disease. He injected half a drachm, passing the needle from the border of the upper lip to the vicinity of the infraorbital foramen.[1] Dr. J. B. Mattison, of Chester, N. J., adopted the same treatment, injecting 20 minims of chloroform. There was severe pain at first, followed by complete relief.[2]

Dr. Henry Hunt published a treatise on tic douloureux, in London, in 1844. He entered largely into the etiology and the medical treatment of the disease. He regarded it as often due to functional disorder or organic disease of the digestive organs, atonic dyspepsia being one of its common causes. When the tongue was heavily furred, and the urine turbid, he recommended an emetic at the beginning of the treatment, followed by a mercurial cathartic. After this preparatory treatment, he often gave with advantage Fowler's solution, beginning with four minims, and gradually increasing the dose to ten or twelve minims three times a day. When this disagreed with the patient, he gave two or three minims of Scheele's prussic acid, and small doses of nitrate of potassium, with three or four grains of James's powder at bedtime. He attached much importance to the use of warm clothing, and to moderate exercise in the open air, avoiding fatigue, especially just before or after eating. For the relief of the severe paroxysms of pain which continued after the removal of visceral congestion, he prescribed opium, belladonna, camphor, and other narcotics. Among these he found belladonna the most efficient. In severe cases he gave one grain of the extract hourly, until three grains had been given. He then suspended the remedy and watched the case. After the first strong impression, he usually found that smaller doses sufficed. He always avoided the use of anodynes while there were symptoms of visceral congestion. As a local application affording temporary relief, Hunt recommended an ointment composed of one grain of aconitine and one ounce of cerate, rubbed upon the part for two or three minutes at a time, and repeated twice a day. Dr. Hunt had seen excellent results from the removal of neuralgic patients from low and damp places to a high and dry locality.

When neuralgia is evidently the result of exposure to malaria, and when the paroxysms recur at regular intervals, it may sometimes be cured by large doses of quinine. The internal use of aconitine has been highly recommended in the treatment of neuralgia. It was brought to the attention of the profession by Dr. Gubler, who published an article on the subject in 1877.[1] Prof. Gubler used Hottot's preparation of nitrate of aconitine, commencing with doses of $\frac{1}{140}$ grain and increasing them when necessary to $\frac{1}{12}$ grain. He regarded heart-disease as contraindicating the drug. Dr. E. C. Seguin[2] has published a report made to the New York Therapeutical Society, giving his experience in the use of aconitine in facial neuralgia. He has obtained good results from the use of this remedy. The internal use of salicylate of sodium in doses of from 1 to 5 grammes daily has been recommended by Dr. Descroizelles.[3] Dr. Howard Pinkney reports a case of facial neuralgia of two years' standing, cured by the use of sulphite of sodium, in scruple doses four times a day.[4] Relief has been afforded by the use of tonga.[5] Drs. Rockwell, Beard, and Neftel report successful results from the employment of electricity.[6] Cases are said to have been cured by hypodermic injections of a two-per-cent. solution of carbolic acid.[7]

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[1] Med. and Surg. Reporter, No. 871.

[2] Med. Record, May 1, 1874, p. 227.

Lennox Brown highly recommends the external application of a mixture of equal parts of chloral hydrate and camphor.[8] Dr. J. Mason Warren, in his Surgical Observations, relates cases in which great relief was afforded by the persistent use of hypodermic injections of morphia. In some of these cases, a permanent cure seems to have been effected. An ointment of veratrine, 10 grs. to ℥j, has been used as an external application with marked advantage, being rubbed over the painful parts at intervals of two or three hours.

The division of the affected branches of the fifth pair of nerves has been resorted to in a large number of cases. In some of these, complete relief has followed the operation, but in most instances the pain has returned after a longer or shorter interval. The mere division of the nerve generally fails to afford a permanent cure. Excision of a considerable portion of the nerve yields better results, but in many cases the cure is not permanent. The operation of neurectomy is often unsuccessful, because the nerve is not excised sufficiently near to its origin. Dr. Carnochan, of New York, is entitled to the credit of having first directed the attention of surgeons to this important fact in the case of the superior maxillary nerve, and of having devised an operation for the excision of the nerve in the immediate vicinity of the foramen rotundum. He performed this operation for the first time on the 16th of October, 1856.[9] He raised a triangular flap, bounded by two incisions extending downward and outward from the inner canthus, and downward and inward from the outer canthus, meeting at a point half an inch in a vertical line below the infra-orbital foramen. From the apex of this triangular flap, a sharp-pointed straight bistoury was next thrust through the cheek into the cavity of the mouth, and an incision was carried downward and inward through the upper lip, dividing it completely to a point midway between the median line and the labial commissure. The upper triangular flap was dissected upward, and the two lower flaps were turned, one inward toward the nose, and the other outward over the malar bone. The anterior surface of the superior maxillary bone, and the lower margin of the orbit, were thus exposed to view. The crown of a trephine, three-quarters of an inch in diameter, was then applied to the anterior wall of the antrum, just below the infra-orbital foramen, and a disk of bone was removed, exposing the cavity. The anterior portion of the trunk of the nerve was now exposed. The infra-orbital canal was next laid open with a delicate chisel and a hammer, and the posterior wall of the antrum dealt with in like manner, exposing the nerve in the spheno-maxillary fossa. The posterior dental nerves were divided, as also the branches going to Meckel's ganglion, and the branch running up to the orbit. Lastly, the trunk of the nerve was divided with blunt-pointed scissors, curved on the flat, close to the foramen rotundum. The hemorrhage was not profuse, and the edges of the wound were brought together with thirteen points of twisted suture. Fourteen months after the operation the patient was in good health, and was entirely free from neuralgic pain. Dr. Carnochan reported two other cases in which he had performed the same operation with results which were good, although a sufficiently long time had not elapsed to test the permanence of the cure.

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[1] Gaz. Hebdom., 9 Fév. 1877; Am. Journ. Med. Sci., April, 1877; Practitioner, Aug. 1877.

[2] New York Med. Journal, Dec. 1878. He has published another paper on the subject in the Archives of Medicine, Aug. 1881, p. 89. See also Med.-chir. Rundschau, Aug. 1878; Med. Record, Dec. 28, 1878, p. 512.

[3] Progrès Médical, 21 Juillet, 1877; Med. Record, Sept. 1, 1877, p. 558.

[4] Med. Record, Dec. 1, 1868, p. 433.

[5] Lancet, March 6, 1880; Med. Record, May 8, 1880, p. 513.

[6] Med. Record, March 15, 1869, p. 28; June 15, 1869, p. 169; Feb. 1870, p. 97.

[7] Allg. med. Cent.-Zeitung, 6 Sept. 1876; Med. Record, Nov. 18, 1876, p. 750.

[8] Brit. Med. Journal; Med. Record, Aug. 1, 1874, p. 404.

[9] American Journal of the Medical Sciences, January, 1858.

Dr. Carnochan's operation has been repeated by a number of surgeons, with variable success. The operations of neurotomy and neurectomy have also been performed with more or less success on the ophthalmic and inferior dental branches of the fifth pair of nerves.[1]

As a substitute for neurectomy, the operation of nerve-stretching has been resorted to with some measure of success in the treatment of facial neuralgia, as well as in that of other nervous disorders.[2]

Burns of the Lips and Cheeks.

These injuries are of frequent occurrence. They are very painful, and greatly interfere with the prehension of food. When they are deep, they are very apt to be followed by cicatricial contractions, which distort the features and greatly disfigure the patient. Special care is required to guard against such distortions. When the face is burned by the explosion of gunpowder, the grains of powder are often deeply imbedded in the skin; they should be carefully removed, one by one, while the patient is under the influence of an anæsthetic.

Frostbite.

The lips and cheeks may be injured by exposure to severe cold, and ulceration, or sloughing, may be the result. The sores may be treated by the application of a stimulating ointment made by the mixture of ʒj or ʒij of oil of turpentine, or of Peruvian balsam, with ℥j of vaseline. The healing process may be attended by cicatricial contraction, requiring the same treatment as that which is demanded when contraction attends the healing of a burn or other severe injury.

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[1] See Annals of Anatomy and Surgery of Brooklyn, April and May, 1880; Med. Record, Nov. 1, 1871, p. 392; Jan. 2, 1872, p. 485; Aug. 18, 1877, p. 520; June 5, 1880, p. 620; Aug. 13, 1881, p. 187; Nov. 15, 1879, p. 468; La France Médicale, 16 Juin, 1877; New York Med. Journal, June, 1879; Ernst Burow, Mittheilungen aus der chirurgischen Privat-Klinik, 1875–1877; Transactions of Am. Med. Association, 1880; J. M. Warren, Surgical Observations; Med. and Surg. Reporter, 1869; Med. Record, Aug. 16, 1869, p. 271; Oct. 1, 1869, pp. 345 and 346; Apr. 1, 1868, p. 60; Jan. 2, 1872, p. 485; Dec. 15, 1877, p. 792; June 19, 1880, p. 701; Oct. 23, 1880, p. 449; Am. Jour. Med. Sciences, 1868 and 1869; Cincin. Lancet and Observer, 1869; Detroit Med. Journal, Nov. 1877; New England Journal of Medicine and Surgery, vol. xii. p. 216; New York Journal of Medicine, Nov. 1856; Transactions of King's County Med. Soc., 1877.

[2] See Brit. Med. Jour., Oct. 18, 1879; Med. News and Abstract, Jan. 1880, p. 49; Quarterly Epitome of Pract. Medicine and Surgery, March, 1880, p. 86; London Med. Record; Hosp. Gazette; Med. Record, March 27, 1880, p. 346; July 24, 1880, p. 111; Aug. 14, 1880, pp. 172, 183; Jan. 15, 1881, p. 71; Jan. 22, 1881, p. 107; Aug. 13, 1881, p. 180; Aug. 27, 1881, p. 245.

Facial Erysipelas.

The integument of the face is peculiarly liable to erysipelatous inflammation. This may occur as a consequence of local injury, or it may be the result of constitutional causes. It may occur sporadically, or it may be endemic, as in the wards of a hospital. It is especially apt to occur where cleanliness and ventilation are neglected. It is apt to be communicated by foul sponges and other similar appliances. It may be simple or phlegmonous in its character. Its general course is the same as that of erysipelas in other parts of the body, but the prognosis is more unfavorable, as the inflammation is very apt to involve the brain and its membranes. The treatment should be prompt and active, to arrest the disease as early as possible. Laxatives and diaphoretics may be administered at the very beginning of the disease, followed by tonics, such as the sulphate of quinia, or the tincture of the sesquichloride of iron. As local applications, blisters may be applied to the surface, or the inflamed parts may be painted with tincture of iodine, or covered with cloths moistened with a solution of sulphate of iron, ʒij to Oj; or hypodermic injections may be made of a 2½ per-cent. solution of carbolic acid.

Malformations and Deformities of the Cheeks and Lips.

Macrostoma.—This term is used to indicate a condition in which the opening between the lips is abnormally large, so as to constitute a marked deformity. The commissures of the lips may be extended outward and backward into the cheeks, on one or both sides, in a horizontal line, or obliquely upward or downward. The deformity may be congenital, or it may be the result of a wound imperfectly healed. It may be successfully treated by paring the edges of the fissure, and uniting them by sutures. In this way, the mouth may usually be restored to its normal size and shape.

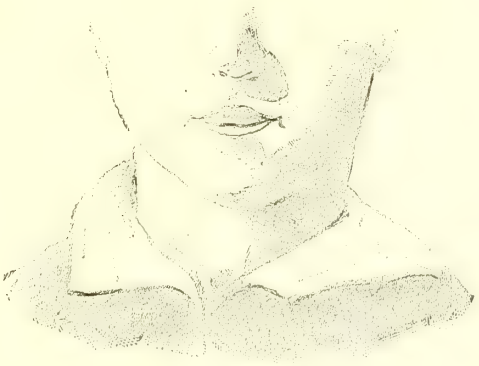
Microstoma.—This name indicates a deformed condition in which the labial orifice is abnormally small. It may be congenital, or it may be the result of cicatricial contraction, following a burn, sloughing, or phagedenic ulceration. In some cases, the opening of the lips is so much contracted as to interfere with the introduction of food into the mouth. The opening may be enlarged by making a horizontal incision on each side into the cheek, and by attaching the mucous membrane to the skin by a number of fine sutures. When the tissues are very much consolidated by cicatricial contraction, there will be difficulty in maintaining the opening, and it will be necessary to stretch the parts mechanically, and to maintain the dilatation for a long period. This dilatation may be effected by metallic arcs introduced into the angles of the mouth, after free incisions have been made, and drawn asunder by elastic bands passing around the back of the neck.

Atresia Oris.—This is described by authors as a congenital defect, in which the anterior buccal orifice is entirely wanting. If such a malformation should be met with, it would be necessary to make a horizontal incision into the cavity of the mouth, and to form a vermilion border for each of the newly constructed lips by uniting the mucous membrane with the skin.

Distortions of the mouth in various directions may be the result of cicatricial contraction from burns, or from other causes. The angles of the mouth may be drawn upward, or downward, or outward and backward; or the lips may be widely separated from each other, so that the mouth cannot be closed, and the saliva cannot be retained. Something may be done, during the process of cicatrization, to prevent these distortions, or to diminish their extent. The principal means to be employed for this purpose are the free application of caustic, methodical pressure by adhesive plasters and bandages—to repress the growth of exuberant granulations—and the stretching of the affected parts in the opposite direction to the threatened distortion. When a large granulating surface is exposed, benefit may often be derived from skin-grafting, inserting small pieces of very thin integument in the midst of the granulations, covering them with goldbeaters' skin, and maintaining close contact for several days by strips of adhesive plaster and bandages. When cicatrization has already taken place, and dense bands of inodular tissue have greatly distorted the buccal orifice, these bands should be freely divided through their whole breadth and depth by a number of parallel incisions, and the healing process should be retarded by keeping the affected parts upon the stretch, and by frequently repeated passive movements. Or, in appropriate cases, a single free and deep incision may be made through the cicatricial band, the margin of the lip may be at once brought into its proper position, and a flap of integument from the vicinity may be inserted, so as to fill up the chasm produced by the incision and by the reposition of the labial margin.

Hypertrophy of the Lips.—This occurs sometimes as a congenital affection, or it may commence at a period subsequent to birth. It may involve either lip or both. When it exists to any considerable extent, it constitutes a very conspicuous deformity, and seriously interferes with the functions of the lips. It presents itself in two forms, partial and general. Partial hypertrophy, which affects chiefly the upper lip, involves the mucous membrane and the submucous cellular tissue, and is usually more prominent on either side than in the median line. It has been described by writers as *Double Lip.* It is cured by excising the hypertrophied parts and bringing together the edges of the wound with sutures. Dr. Agnew, in his work on Surgery,[1] gives a wood-cut of Double Lip. (Fig. 935.) General hypertrophy of the lip involves the skin and mucous membrane

Fig. 935.



Double lip. (After Agnew.)

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[1] Principles and Practice of Surgery, vol. ii. p. 891.

with all the intervening tissues. It is treated by excision of a wedge-shaped segment of the lip, the base of the wedge corresponding with the vermilion border. An interesting case of this deformity, illustrated by wood-cuts, is described by Dr. Buck.[1]

HARELIP.

Harelip is a congenital malformation of the upper lip, resulting from arrest of development, and presenting, in the more mature state, a continuance of that which is the normal condition in the earlier stages of embryonic development. It derives its name from its resemblance to the cleft which exists in the upper lip of the hare, the rabbit, and other allied animals. It consists of a fissure, usually extending through the whole thickness of the lip, from the nose to the vermilion border. There are several varieties, indicated by the names single and double, simple and complicated. The term single implies that there is but one fissure. The term double denotes that there are two. A simple harelip is one in which there is no concomitant malformation of the upper jaw or palate. A complicated harelip is one in which there is a deviation from the normal development of the jaw or palate, or in which the malformation involves both of these parts.

In a *single harelip*, the fissure is rarely situated exactly in the median line. In the large majority of cases it is on the left side, so that the right portion of the lip is broader than the left. In some cases the fissure involves only the lower portion of the lip, not extending up to the nose. In some cases the margins of the fissure are nearly parallel, and are almost in contact, while in other cases they are widely divergent towards the free border of the lip.

In *double harelip*, the two fissures are usually on the two sides of the median line, and the intermediate portion may be quite narrow, or may be of considerable breadth. It is usually broader towards the nose than towards the free margin of the lip. In many cases it does not extend as low as the free border of the lateral portions of the lip.

In *complicated harelip*, the malformation of the upper jaw may be twofold. There may be an advance of the median portions of the superior maxillary bones far beyond their ordinary position, these projecting portions being detached from the main body of the jaw, and constituting intermaxillary bones such as exist normally in some of the inferior animals. The middle incisor teeth are usually developed in these intermaxillary bones. Or, instead of a projection of the maxillary bones, there may be a fissure, single or double, extending through the alveolar portion of the jaw. The fissure may also involve the bony and soft palate. In many cases of complicated harelip, the abnormal prominence of the jaws and fissures of the bony and soft palate are found to coexist. In such cases, when the harelip is double as well as complicated, the columna nasi is generally deficient, and the portion of the lip intermediate between the two fissures is attached above to the tip of the nose and behind to the projecting intermaxillary bone, and seems to be an appurtenance of the nose rather than of the lip.

In the majority of cases, harelip occurs sporadically, not showing any remarkable tendency to affect different members of the same family. But I have become acquainted with two families in which nearly all of the children presented some variety of this malformation. In one of these families, the mother also had harelip.

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[1] Contributions to Reparative Surgery, pp. 159–164.

Demarquay reports the case of a family in which, in three generations, eleven persons had either harelip or malformation of the lower lip.[1]

The *treatment* of harelip consists in paring the margins of the fissure, bringing the two raw surfaces into close contact with each other, and holding them together by sutures until the two sides of the lip have become firmly united. This is a comparatively easy matter when the fissure is both single and simple, when the two sides of the lip are nearly symmetrical, when they are nearly parallel, and when they are not widely separated from each other. But under less favorable conditions, it is often a matter of great difficulty to secure union of the two sides of the lip without some remaining deformity. Without great care on the part of the surgeon, there is apt to be a want of conformity in the line of the vermilion border on the two sides of the lip, and there is often a more or less conspicuous notch in its free border.

It is very important, in order to insure the complete success of the operation, that the two sides of the lip should be brought together without tension, and that they should be maintained in close contact while, at the same time, the sutures are so applied as not to make injurious pressure.

In the simplest and most favorable cases, the following are the steps of the operation. A broad bandage is applied around the child's trunk and upper extremities, so as to prevent him from moving his hands during the operation. He is then placed upon a table or on the lap of an assistant, brought under the full influence of an anæsthetic, and kept in a supine position. A needle armed with a strong thread is next passed through the lip near the junction of one side of the fissure with the vermilion border, and the two ends of the thread are tied so as to form a loop about six inches in length. Another thread in like manner is passed on the other side of the fissure, and its ends secured in the same way. These loops facilitate the subsequent steps of the operation, by enabling the surgeon or his assistant to make traction in any required direction. The two sides of the lip are then drawn together, and if any resistance is offered to their close approximation, a free division of the mucous membrane and of the submucous cellular tissue is made on either side with scissors curved on the flat, until the resistance is completely overcome. The sides of the fissure are now to be pared so as to present broad surfaces denuded of integument. This is best accomplished by making downward traction by means of the loop of thread on one side of the fissure, and then inserting a Beer's cataract knife through the lip just above the loop, with its cutting edge looking upward, and cutting up towards the nose. The knife is then inserted on the other side of the fissure, and the incision completed in the same manner. It is not usually necessary to tie any vessels, as the lip can be compressed between the thumb and finger of an assistant until the surgeon is ready to apply the sutures. The edges of the wound are to be brought together by a pin passed through the two divisions of the lip, midway between its free border and the nose. The pin should enter on one side and emerge on the other about seven or eight mm. from the margin of the fissure, and should penetrate the whole thickness of the lip, except the mucous membrane. A number of turns of darning cotton should then be passed around the ends of the pin in the form of the figure 8. The sides of the lip should be brought together so that the two lateral portions of the vermilion border should exactly correspond. A second pin should be applied in the same manner at the junction of the skin with the vermilion border on each side. A third suture, of fine silk, should be applied near the junction of the lip with the nose. A fourth suture, also of fine silk, may be applied through the vermilion border, and a fifth through the mucous membrane. The two last named sutures are often omitted, but I think that they secure a more perfect coaptation of the two divisions of the lip. I think it best to trust entirely to the sutures to hold the sides of the lip together, and to dispense with adhesive plasters, which are entirely unnecessary, and which are a source of discomfort and irritation. The sutures may be removed on the fourth or fifth day, and then the lip should be supported by a strip of adhesive plaster having a narrow isthmus across the lip, and a broad circular expansion over each cheek. If the support of the adhesive plaster be omitted after the removal of the sutures, there is reason to fear that the uniting medium may become attenuated, and that the middle portion of the lip may present an abnormal, sunken appearance. The adhesive plaster should be renewed from time to time, and its use should be continued for two or three weeks.

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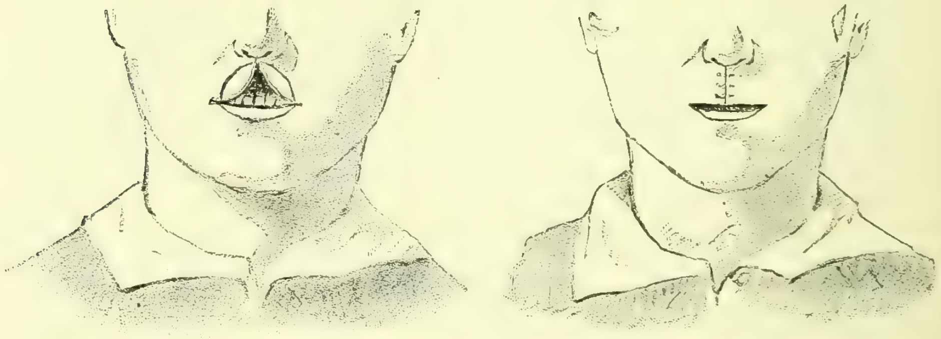
[1] See Med. Record, Oct.1, 1868, p. 348.

In cases in which the fissure is broad, and its margins widely divergent towards the free border of the lip, the edges may be pared by a semi-elliptical incision on either side, the concavities looking towards each other, and in this way the formation of a notch at the vermilion border may be avoided. (Figs. 936 and 937.)

Fig. 936. Fig. 937.



Operation for harelip with divergent margins.

Or in cases in which the divergence is still greater, the method of Malgaigne, called by Agnew the method of Collis, may be adopted. This consists in leaving the flaps pared from the margins of the fissure, attached to the vermilion border of the lip, reflecting them downwards so that their raw surfaces are brought into contact. These flaps are trimmed to a proper length, and are then secured by sutures, so as to form a prominence beneath the inferior edge of the lip. (Figs. 938 and 939.) I have found this a most effectual mode of guarding against the occurrence of a notch. After the wound has healed, and when the subsequent contraction has reached its full limit, if the prominence should continue, it may readily be reduced to its proper level.

In cases in which there is a marked inequality in the breadth of the two sides of the lip, the margin of the fissure on the narrower side may be pared three-fourths of the distance from the nose to the vermilion border, the incision being then sloped outwards to the free margin of the lip, while on the broader side the incision does not extend quite to the vermilion border, and

Fig. 938.

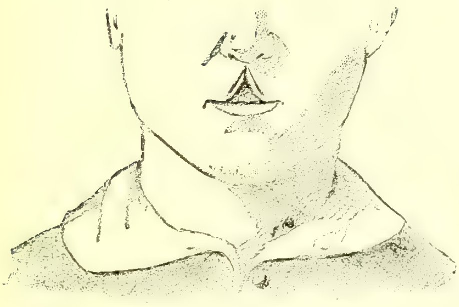
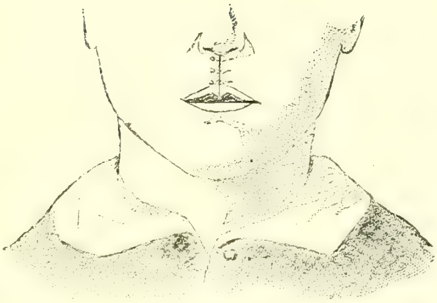


Fig. 939.



Malgaigne's operation for harelip.

the small flap dissected from the margin is made to overlap the lower margin of the narrower side. (Figs. 940 and 941.)

Fig. 940.

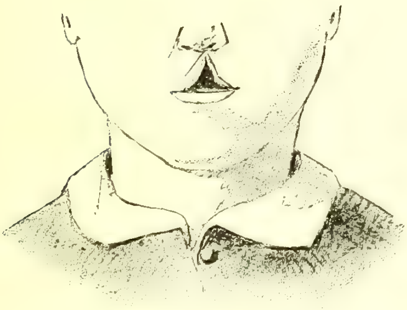
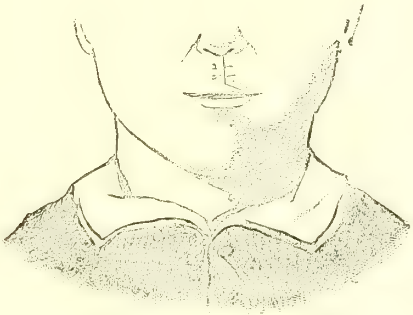


Fig. 941.



Operation for harelip with marked inequality of sides.

When the fissure is very wide, and when the lateral portions of the lip cannot otherwise be approximated without undue tension, incisions may be made outwards into the cheeks from the junction of the lip with the nose, and, if necessary, from the angles of the mouth.

In cases of double harelip, not complicated with deformity of the jaw, if the portion of the lip intermediate between the two fissures is of considerable breadth, and extends nearly or quite down to the level of the free borders of the lateral portions, the operation may first be performed on one side, and after the wound has healed, and when the union has become firmly consolidated, may be repeated on the other. But when the intermediate portion is of smaller dimensions, the operation on both sides may be completed at the same time.

In cases of harelip complicated with intermaxillary projection, the prominent portion of the jaw may, in very early infancy, be pressed back to its proper level. This may be accomplished with the thumb and fingers, or with strong forceps guarded with buckskin. But when the bone has become too firm to be reduced in this way, it may be partly divided with Butcher's forceps, and then pressed back into its position. In children of larger growth, or in persons of mature age, the projecting portion of the jaw must be removed, with the aid of a saw, chisel, or cutting-forceps.

In cases of double, complicated harelip, where the columna nasi is deficient, and where the intermediate portion of the lip appears to be an appurtenance of the nose, this portion of the lip should be used in the reconstruction of the columna nasi. For this purpose it should be dissected off from the projecting portion of the bone, and should be reflected backward so that its posterior surface may be applied to the inferior part of the septum nasi, the two corresponding surfaces being freshened for the purpose, and being held in contact by one or more sutures. It is best, in such cases, to leave the new columna of its full breadth, until it has firmly united with the adjacent parts, and then to trim it to its proper size and shape.

There is a difference of opinion among surgeons as to the best time of operating for harelip, when the surgeon is consulted at the time of birth. There is a general agreement that the operation should be performed before the commencement of dentition. In cases of simple harelip, whether the fissure be single or double, I would recommend the performance of the operation about three or four months after the birth of the child, as at that time the parts have acquired a good degree of development, and the irritation of dentition has not yet commenced. But in cases of complicated harelip, whether there be maxillary projection, or fissure of the alveolar portion of the jaw and of the bony palate, it is better to operate at a much earlier period, as the pressure of the reconstructed lip exerts an important influence in diminishing the deformity of the bones while they are in a soft and yielding condition. Some surgeons recommend the performance of the operation on the day of the child's birth. This practice seems to me objectionable, as the child has not yet recovered from the shock attending the transition from intra-uterine to extra-uterine life. New-born infants generally lose weight during the first week of extra-uterine life, and do not regain what they have lost until after the lapse of another week. I think that the most favorable time for the performance of the operation, in these complicated cases, is when the child is three or four weeks old, as at that time the functions of extra-uterine life, circulation, respiration, and digestion, have become fully established, and the bones of the face have not yet undergone any remarkable increase of solidification.

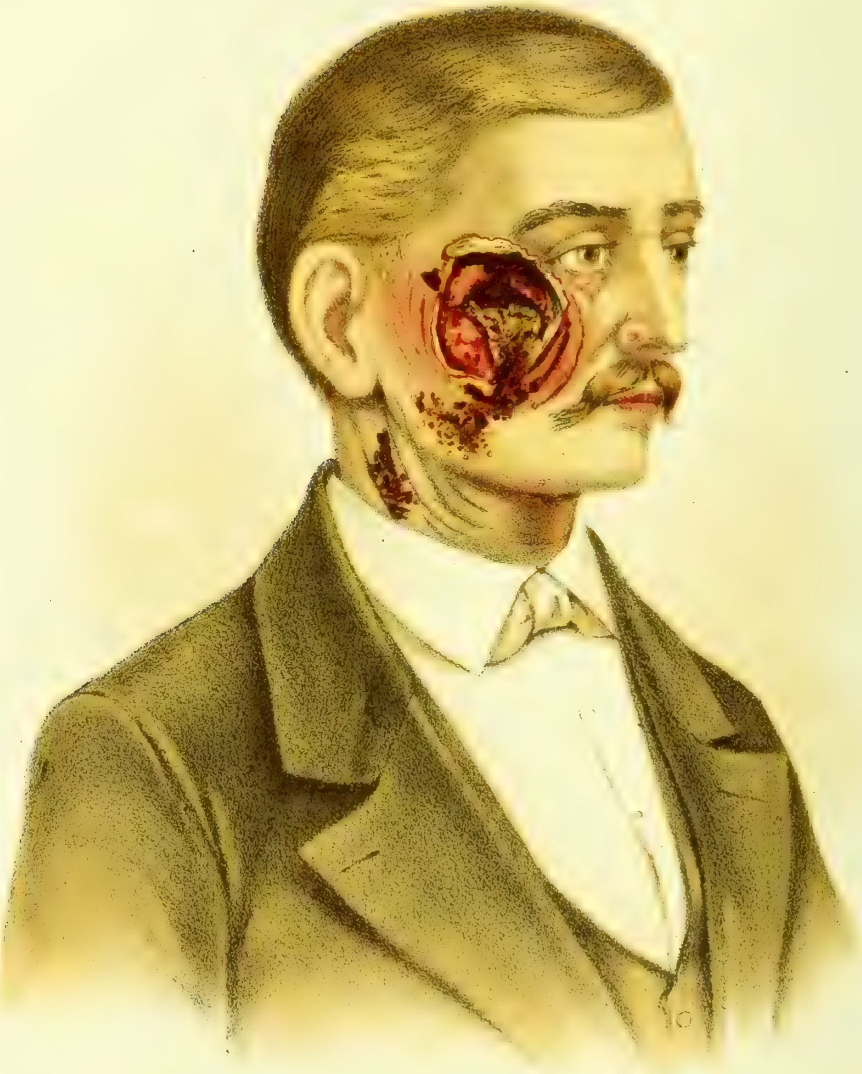
If the surgeon is not consulted until the child is five or six months old, it is generally best to defer the operation until the first dentition is completed, as during the progress of dentition children are more subject than at other periods to convulsions and other serious derangements of the nervous system.

A *congenital fissure in the median line of the lower lip* has been observed in a very small number of cases. The treatment is like that of simple harelip.

Wounds of the Lips.

These wounds bleed very freely, but the hemorrhage may be readily arrested by torsion or by ligature; or the sutures, by which the wound is closed, may be so adjusted as to compress the bleeding vessels. When the

PLATE XXXI.



Epithelioma of face.

(From a Patient in the Hospital of the University of Pennsylvania.

H. BENCKE, LITH. N.Y.

wound involves the vermilion border, the edges should be very carefully adjusted by sutures, so as to guard against the occurrence of permanent fissure, and secure perfect symmetry in the line of union.

Furuncle and Carbuncle of the Lips.

These forms of gangrenous inflammation are often observed in the lips. They are very painful, and are often attended with marked symptoms of cerebral disturbance, sometimes leading to fatal results. The special danger of the disease in this situation has been ascribed to absorption of septic poison by the facial vein. The most reliable treatment consists in free incision through the whole thickness of the inflamed and indurated parts, followed by stimulating dressings, such as lint moistened with oil of turpentine, or balsam of Peru. The best results are obtained when the incision is made at a very early period of the disease. The incision should be made through the free border of the lip.

At a very early stage of the disease, the morbid action may be promptly arrested by the application of a cauterizing needle to the depth of three or four millimetres, at several points along the labial margin. If this is done under the influence of an anæsthetic, it is not a severe remedy, and it does not disfigure the patient.

Fissures of the Labial Margin, or Cracked Lips.

These are usually the result of exposure to cold, and they are most apt to occur when there is some derangement of the general health. When the lip is stretched, they are very painful, and they are disposed to bleed. They will generally heal when they are protected from cold and are occasionally touched with sulphate of zinc, sulphate of copper, or nitrate of silver. When they are neglected, they may lead to deep ulceration of an intractable character, sometimes requiring excision. Obstinate fissures at the angles of the mouth should lead to careful investigation as to a possible syphilitic origin.

Ulcers of the Cheeks and Lips.

Aphthous ulcers of the mucous membrane of the lips are apt to be very painful. Great relief is often afforded by touching them with sulphate of zinc, sulphate of copper, or nitrate of silver, but the application for the moment gives severe pain. Attention should always be paid to the general health, and especially to the digestive organs. A charcoal mixture, or a mixture of rhubarb and soda, will often be of great service.

Lupus.—This disease may affect the lips and cheeks, assuming the form of either lupus exedens or lupus non-exedens. It often greatly disfigures the patient. The affected parts may be excised, or they may be destroyed by the actual or potential cautery. If the extent of the disease be limited within narrow bounds, the edges of the wound, after incision, may be brought into contact, and secured by sutures. But when there has been great loss of substance, a plastic operation will be required to fill up the chasm.

Rodent ulcer and epithelioma (Plate XXXI.) may both occur in the same situations as lupus, and may require substantially the same treatment.

SYPHILITIC AND CHANCROIDAL ULCERS may occur upon the lips, the virus of the former being usually applied in the act of kissing. These sores present in their main features the same characters, and require the same treatment, as when they are found on the genitals.

CANCER OF THE LIP.

This is a very common disease in the male subject after the age of forty-five years. It affects almost exclusively the lower lip, although, in some rare instances, it has been observed in the upper lip. It is comparatively rare in females. In the great majority of cases it presents the characters of epithelioma. There seems to be good reason to believe that tobacco smoking plays an important part in the production of the disease, and that it occurs more frequently in those who smoke clay pipes, than in those who use other kinds of pipes, or who smoke cigars. Dr. J. Mason Warren, in his Surgical Observations, gives the statistics of all the cases of cancer of the lip which had occurred at the Massachusetts General Hospital for forty years:—

Whole number of cases	77
Males	73
Females	4
No. of those that smoked pipes	44
No. that did not smoke pipes	7
Not ascertained	26

Of the four women, three were known to have smoked pipes. Epithelioma of the lip, in its earliest stage, may present itself as a simple desquamation of the cuticle at the margin of the lip, with a slight induration of the subjacent tissue, or there may be a crack or fissure, or a wart-like growth from the surface, or a small, hard tubercle like a shot imbedded in the part. In either case, there is apt to be some induration, but it is often very slight. The disease, in its early stage, is often quite indolent, scarcely giving rise to any symptoms, and frequently remaining many months without making any considerable progress. After a time, varying greatly in different cases, it assumes a more active character, extending along the vermilion border and through the substance of the lip, and giving rise to lancinating pains. At a later period, ulceration takes place, with an offensive sanious discharge, and the disease extends along the lymphatics to the glands beneath the base of the jaw, and involves all the adjacent tissues, including the periosteum and the bone. The general health becomes seriously disturbed, and the continued irritation and exhaustion, occasioned by the disease, ultimately destroy the patient's life.

Treatment.—The only safety of the patient lies in the early and complete extirpation of the parts involved in the disease. This may be accomplished by the thorough application of powerful escharotics; but their action is painful, slow, and uncertain in its results. Excision with cutting instruments is more prompt, more safe, and more certain, and is attended with much less pain and discomfort to the patient. It is also followed by a much smaller deviation from the normal appearance of the face, and is, therefore, on all accounts to be preferred. When the disease involves less than half of the vermilion border of the lip, it may readily be included in the limits of a V-incision, and the margins of the wound may be brought together with pin sutures in such a manner as scarcely to mar the appearance of the patient. When a larger portion of the lip is involved in the disease, it may be excised by a semi-circular, a semi-elliptical, or a quadrangular incision, and the chasm thus produced may be closed by an appropriate cheiloplastic operation.

When epithelioma of the lip is removed at a very early period, there is good reason to hope for a radical cure, or, at least, for a long reprieve. But if the operation be delayed until the lymphatic system has become involved, and till the general health has begun to suffer from cancerous cachexia, little or no benefit is to be expected from the excision of the morbid growth.

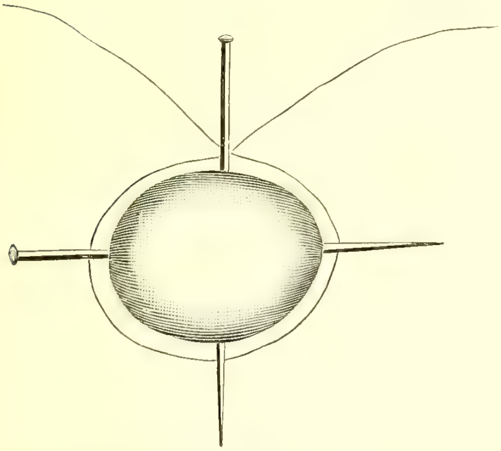
Telangeiectasis of the Lips.

This is usually a congenital affection. It may affect the vessels of the skin or mucous membrane alone, or those of the subjacent cellular tissue, or both tissues may be involved. When the disease is of very limited extent it may be excised, and the edges of the wound may be united by sutures.

When it is more extensive, it may be treated by inserting cauterizing needles, at a dull-red heat, into the tumor at a number of points.

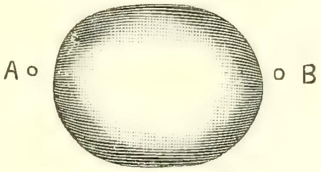
When the morbid growth is quite prominent, without a very wide base, it may be treated with two pins traversing its base and crossing at right angles, and a strong ligature tied around the base of the tumor under the pins, with sufficient force to arrest the circulation and to destroy the vitality of the included parts. After the separation of the slough the sore will heal, and the cicatrix will not much disfigure the patient. Fig. 942 shows the pins *in situ*, traversing the base of the tumor, and the ligature ready to be tied. It will sometimes be advantageous to apply the ligature around the base of the tumor subcutaneously, as represented in Fig. 943. A curved needle armed with a strong ligature is passed through the integument at the point A, on one side of the tumor, and is carried beneath the skin around half the circumference of the tumor to the point B, on the opposite side. It is then re-inserted at the point B, and carried from B to A around the other half of the circumference, and thus the two ends of the thread at A may be tied so as to strangulate the tumor subcutaneously.

Fig. 942.



Telangeiectasis of lip strangulated with pins and ligature.

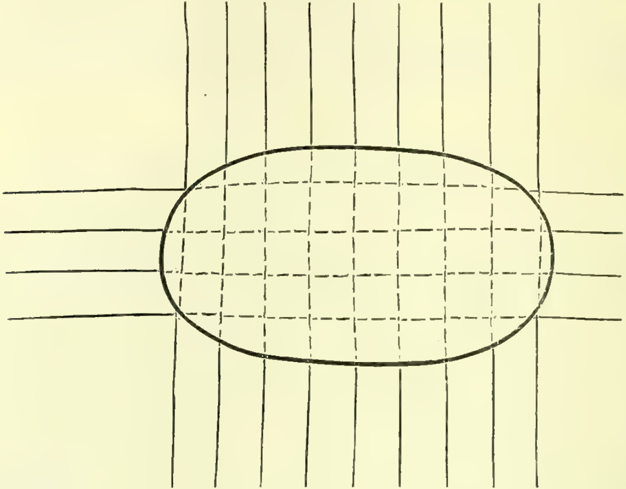
Fig. 943.



Application of subcutaneous ligature.

When the tumor is flat and has a broad base, it may be treated by passing needles armed with double ligatures through its base, at a number of points, and tying in sections until the whole circumference is strangulated. Or a number of parallel ligatures may be passed through the tumor, and intersected by others at right angles, as represented in the diagram. (Fig. 944.) When the two ends of each ligature are firmly tied in the direction of the dotted lines, the whole mass will be divided into quadrangular segments, and the vascular growth will be obliterated.

Fig. 944.



Telangeiectasis of lip strangulated by ligatures crossing each other at right angles.

PORT-WINE MARKS.

Dark discolorations of the integument of the face, forming circumscribed patches resembling in color the stains occasioned by port wine, are sometimes observed as a congenital affection. They are only important as affecting the personal appearance of the patient. When they are small, they may be excised, or the surface may be destroyed by means of the actual or potential cautery. In 1876, a pamphet was published by Dr. Balmanno Squire, describing his method of treating port-wine marks. His plan is to freeze the part by the ether-spray apparatus, then scratch it with an ordinary cataract needle in parallel lines about one-sixteenth of an inch apart, then place a piece of blotting paper on it before it has thawed, pressing the paper firmly on the scratched skin for five minutes. Next day he repeats the operation if necessary, the lines being in an oblique or transverse direction to the original scratches. The scratches need not divide the entire thickness of the skin. The part must be well frozen, both that the operation may be painless, and to avoid any hemorrhage. In applying the blotting-paper, the pressure should be absolutely perpendicular to the surface; for if the slightest lateral traction be made, the miniature incisions will gape slightly, and so become plugged with minute, wedge-shaped clots of blood, with resulting, indelible, linear scars. After relaxing the pressure, the paper should be allowed to remain for at least half an hour. Then it should be thoroughly wetted, and gently removed, traction being made in the same direction as the incisions, so as not to tear them open. The thin clot of blood which covers the part after removal of the paper, should be gently washed off with a camel's hair brush and cold water, and then a film of glycerine should be carefully applied.

Dr. Squire has since proposed to make the linear incisions of the skin oblique instead of perpendicular to the surface, and has devised an instrument for the purpose, which he calls a multiple linear scarifier.[1]

CYSTS OF THE LIPS.

Cysts, arising from distension of the follicles and containing a viscid fluid, are sometimes found at the margins of the lips. They may be excised, or they may be laid open so as to evacuate the fluid, and the surface may then be wiped with lint and cauterized with nitric or sulphuric acid.

TUMORS OF THE LIPS.

Tumors of various kinds occasionally present themselves in the lips, such as steatomata, adenomata, papillomata, myxomata, sarcomata, fibromata, and lipomata. Soft papillomata may be destroyed by escharotics, but the other varieties of tumor may more advantageously be excised.

HIRSUTIES.

A growth of hair from the lips and cheeks, in the female, is often an occasion of great annoyance. When they are not very numerous, the hairs may be plucked individually with forceps, and the evulsion may be repeated as often as they are reproduced. Dr. Agnew recommends, as a depilatory, three parts of prepared chalk and one part of sulphide of calcium, mixed into a paste with water, and applied to the surface with a brush. After it has dried, it may be rubbed off, and the hairs are removed with it; but, after a while, they are reproduced. A radical cure may be effected by destroying the hair follicles, one by one, by inserting into them a platinum needle and connecting it with the poles of a galvanic battery.

CHEILOPLASTIC OPERATIONS.

These operations consist in the transplantation of flaps to supply new material for the reconstruction of the lips, when a considerable portion of their substance has been destroyed by disease or by injury. The flaps employed for this purpose are, for the most part, taken from adjacent parts of the face or neck, and are left attached by pedicles to the parts from which they derive their nourishment until they have become firmly adherent in their new position, and have obtained a new vascular supply from the parts into which they have been inserted. The grafting of flaps without a pedicle is not well adapted to the supply of new tissue in a part as movable as the lip, and which cannot well be kept entirely at rest and subjected to pressure, on account of the necessity of introducing food into the mouth. To remove the deformity arising from a loss of substance of the lips, in such a manner as to restore the symmetry of the mouth, often taxes the ingenuity of the surgeon to its utmost limits. The operations which have been devised for this purpose present a great variety of details, according to the nature and extent of the deformity, and the character of the material of which the surgeon can avail himself in restoring the disfigured features to a condition approaching as nearly as possible to their normal configuration. To obtain anything like a satisfactory result, it is essential that the transplanted flaps should be composed externally of skin, and internally of mucous membrane. The lips and cheeks are the only available material for this purpose, and the French method of approximating the transplanted flaps to the part to which it is to be attached, without twisting its pedicle, is the only method of which we can ordinarily avail ourselves. The disadvantage of this method, in cases where there is a large chasm to be filled up, is that the flaps cannot be adjusted to each other without such a degree of tension as to endanger the success of the operation. This difficulty may sometimes be overcome by making free incisions beyond the base of the flap, to relieve the tension, and by allowing the space thus made vacant to heal by granulation and cicatrization. The healing of this space may sometimes be promoted by skin-grafting.

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[1] See Med. Record, Feb. 17, 1877, p. 107, and Jan. 17, 1880, p. 64; Med. Press and Circular, Nov. 26, 1879; Quarterly Epitome of Pract. Med. and Surg., March, 1880, p. 91.

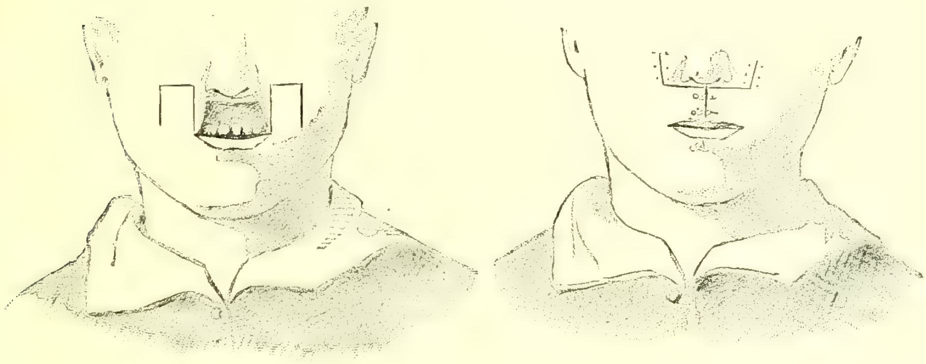
Another mode of relieving the tension of the flaps is to give a very considerable curvature to their peduncles. In many cases the success of the operation will greatly depend on the adoption of this expedient. In cases in which there is a very great relative deficiency of the lower lip and superfluity of the upper lip, or *vice versa*, a flap may be transplanted from the superfluous lip to supply material to the defective one, by one of the ingenious processes of the late Dr. Gurdon Buck. This seems to be almost the only condition in which a cheiloplastic operation may be advantageously performed by the Indian method. In cases in which there is a very contracted state of the mouth, and in which there is no available mucous membrane in the vicinity to invest the borders of the lips which are to be reconstructed, it has occurred to me that the difficulty might be obviated by transplanting a flap of integument from the neck, and inserting it through an incision along the base of the lower jaw, so as to line the outer integument, and supply the place of mucous membrane. When there is no suitable integument in the immediate vicinity of the face, a flap of integument may be partially detached from the thorax or abdomen, and attached to the margin of the hand or forearm, and at a later period it may be secondarily transplanted so as to form a mucous lining in the lip or cheek.

Cheiloplastic operations may be divided into four classes, according as they are designed (1) to supply deficiencies of the upper lip; (2) To supply deficiencies of the lower lip; (3) To supply deficiencies of both lips; and (4) To supply deficiencies or correct malpositions of the angles of the mouth.

In cases of harelip, in which there is a very wide chasm to be filled, it is sometimes necessary to make an incision outward and backward on each side from the angles of the mouth, through the whole thickness of the cheeks, and a parallel incision at the junction of the lip with the nose, thus making flaps from each side to bridge the chasm. In such cases, a new vermilion border to the upper lip is made by attaching the mucous membrane to the skin by fine sutures. If the flaps do not meet without tension, the incisions may be prolonged in a curved direction outward and downward, until the tension is entirely relieved.

Dieffenbach proposed a plastic operation for the restoration of the upper lip, by making a vertical incision upward from the angle of the mouth to a point above the level of the nostril, thence making a horizontal incision outward to an extent fully equal to the breadth of the space to be occupied by the reconstructed lip, and thence a vertical incision downward nearly to the level of the angle of the mouth, thus making a quadrangular flap remaining attached below. This flap was to be turned horizontally inward, so that its upper border should in the median line be secured by sutures to a corresponding flap on the opposite side. (Figs. 945 and 946.)

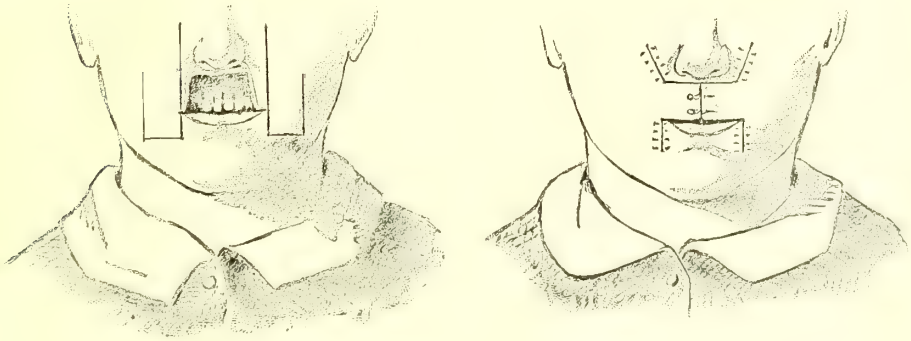
Fig. 945. Fig. 946.



Dieffenbach's operation for restoration of upper lip.

Sédillot proposed another operation by which the restoration of the upper lip was to be effected by means of flaps cut in the reverse direction from that proposed by Dieffenbach. The flap on each side was bounded by a vertical line, commencing at a point midway between the angle of the mouth and the lower eyelid and ending midway between the angle of the mouth and the base of the lower jaw; a horizontal line extending outward from the lower extremity of the vertical line, and another vertical line extending upward from the outer end of the horizontal line to a point on a level with the nostril. These flaps were then to be turned so that their lower extremities should meet and be joined by sutures in the median line. (Figs. 947 and 948.)

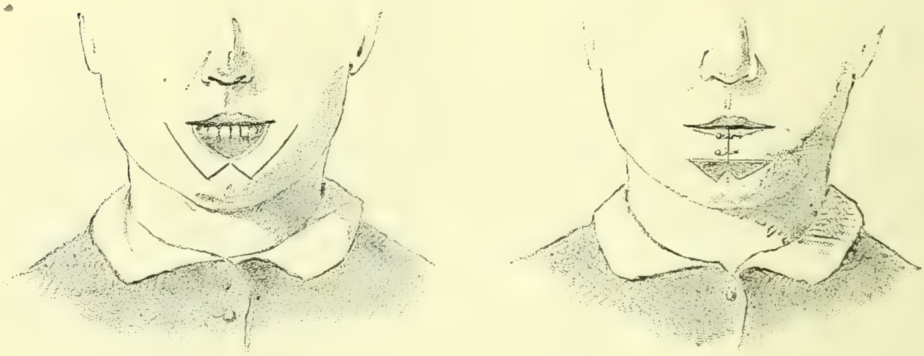
Fig. 947. Fig. 948.



Sédillot's operation for restoration of upper lip.

Deficiencies in the lower lip are apt to exist to a greater extent than those which occur in the upper lip. Malignant disease is the most frequent cause of these extensive deficiencies. When a cancer of the lower lip occupies so large a portion of its margin that it cannot be excised by a V-incision, allowing the opposite sides to be brought into contact and secured by sutures, a plastic operation is required for the reconstruction of the lip. When the disease involves nearly the whole of the vermilion border, but does not extend very far towards the chin, the operation proposed by Buchanan may be performed with advantage. In this operation, the morbid growth is removed by a semicircular incision, and then a flap is cut on each side, bounded above by the incision referred to, below by a parallel curved incision, and within by an oblique incision extending on each side of the median line downward and outward from the upper to the lower curved incision. These flaps are drawn upward and inward so as to meet in the median line, and their upper margins are brought into contact with the upper lip, leaving a considerable chasm to granulate between their lower borders and the chin. (Figs. 949 and 950.) This chasm may sometimes be filled up by making an incision through the integument of the neck, nearly parallel on the sides with the lower border of the chasm, but the two lateral portions as they approach the median line extending downwards and meeting at an acute angle in the median line. The flap thus made may be drawn upward to meet the upper margin of the chasm, and the sides of the triangular space below may be united by sutures.

Fig. 949. Fig. 950.



Buchanan's operation for restoration of lower lip.

Instead of Buchanan's operation, the tumor may be removed by including it in a quadrangular incision, bounded above by the free border of the lip, below by a horizontal line parallel with the free border, and on each side by a vertical line extending from the labial margin to the lower horizontal line. The two vertical lines are then extended downward below the base of the jaw, and the flaps thus formed are used to fill up the space which had been occupied by the excised portion of the lip. The objection to this mode of operating is that it is difficult to prevent the new margin of the lip from sinking down below its proper level. I think that this difficulty might be obviated by dividing the base of the flap into two lateral segments separated from each other by a triangular portion of integument, and then curving these lateral peduncles outward and upward so as to relieve the tension of the flap. The triangular chasm between the two peduncles could then be closed laterally by sutures. Whichever of these methods may be adopted for supplying deficiencies of the lower lip, a new vermilion border should be made, when it is practicable, by uniting the mucous membrane with the skin by means of fine sutures. When this cannot be accomplished, the free border of the lip may be invested with skin, if this material can be obtained for the purpose.

The operations of Dr. Buck for the transplantation of a portion of the upper lip to supply a deficiency of the lower lip, or of a portion of the lower lip to supply a deficiency of the upper lip, are described in his Contributions to Reparative Surgery, published in 1876.[1]

He first describes two preliminary operations for the removal of extensive disease of the lower lip.

The first of these preliminary operations is performed by including the diseased mass between two incisions extending downward and inward from a point on each side near the angle of the mouth, and meeting in the median line of the neck beneath the chin. The mucous membrane is then freely divided on each side at its reflection from the cheek to the jaw, and the margins of the wound are drawn together, and united by pin sutures.

The second preliminary operation, which is adapted to cases in which the extent of the disease is so great as to forbid the first operation, consists in the exsection of the tumor by two vertical incisions extending downwards from the commissures of the lips, and a horizontal incision extending from one of the vertical incisions to the other, below the diseased mass. The horizontal incision is then extended to the right and left, to within a finger's breadth of the angle of the jaw, and thence curved upward and a little forward over the masseter muscle to the extent of about two inches. The flaps are then dissected from the subjacent parts, and their edges brought together in the median line, and secured by pin sutures. The vacant spaces behind the posterior vertical incisions may be allowed to heal by granulation, or the integument may be dissected up from the parts behind, and united by sutures with the posterior margins of the flaps. After the healing of the wounds made by either of these preliminary operations, the mouth is much disfigured, the angles being much approximated and the upper lip being redundant, and overhanging the lower lip which is extremely contracted. The secondary operation, which is designed to transfer the redundant portions of the upper lip, so as to relieve the contracted state of the lower lip, and thus to restore the symmetry of the mouth, is performed as follows: A point is selected about a finger's breadth below and a little without the angle of the mouth on each side, and this point is marked by inserting a small pin through the skin. Another pin is inserted on each side at the junction of the vermilion border of the upper lip with the skin, about one-fifth of the distance from the angle of the mouth to the median line of the lip; and a third pin on each side is inserted into the integument of the cheek, about an inch and a half above and without the angle of the mouth. The points indicated by the first and third pins are then to be united by an incision through the entire thickness of the cheek, and, in like manner, the points indicated by the second and third pins. A triangular flap is thus formed, with its base towards the angle of the mouth, and from the point indicated by the first pin a vertical incision is made down to the base of the jaw. The integument in this region being in a state of great tension, the edges recede and form a space for the reception of the triangular flap with its apex towards the base of the jaw, and its base, including a portion of the vermilion border of the upper lip, supplying the deficiency of the corresponding side of the lower lip. When this operation is completed on both sides, it greatly improves the configuration of the mouth.

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[1] Contributions to Reparative Surgery, chap. v. pp. 20–30. New York, 1876.

With slight modifications, this operation may be reversed, the redundancy of the lower lip contributing to supply the deficiency of the upper. (Figs. 951 and 952.)

Fig. 951.

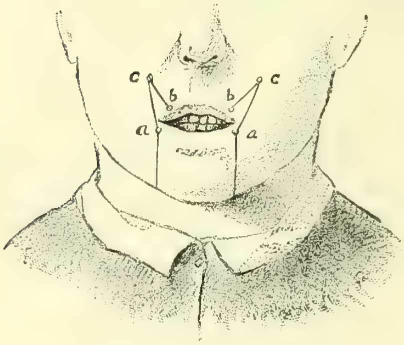
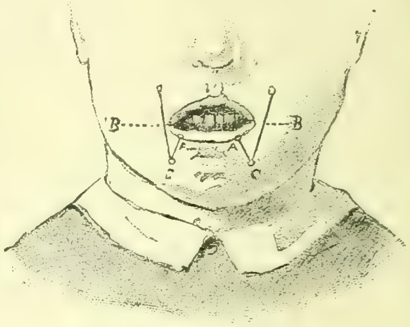


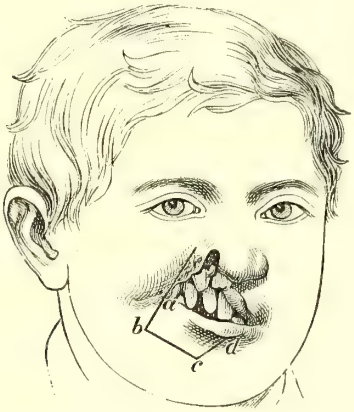
Fig. 952.



Buck's operation for restoration of lower lip.

Dr. Buck's second operation, which is designed, in certain cases of deficiency of one side of the upper lip, to supply material from the lower lip, is performed in the following manner: The upper lip on the defective side is separated from the cheek by a vertical or slightly oblique incision, involving its whole thickness, and extending downward an inch below the angle of the mouth. From the lower part of this incision, a second incision is made, extending inward almost to the median line, and a third incision, from the inner extremity of the second, upward half way to the vermilion border. The opposite half of the upper lip is to be prepared for the reception of the flap from the lower lip by free incision of the mucous membrane connecting it with the jaw, and by paring its edge, so as to leave a raw surface. The flap from the lower lip is then turned edgewise so as to meet the opposite side of the upper lip, the vermilion border of the lower lip being reversed so as to form a part of the border of the upper lip. The flap is attached by sutures in its new position. When the healing process has been completed, the commissure of the lips presents a circular instead of an angular form, and requires another operation to give it its proper shape. This operation is performed in the following manner: A curved incision is made along the line of junction of the skin with the vermilion border, extending to an equal distance along the upper and lower lips. This incision should divide the skin and the subcutaneous tissue, but should not involve the mucous membrane. A sharp-pointed double-edged knife is then inserted between the skin and mucous membrane, and these parts are freely separated from each other, as far outward as the point where the new angle of the mouth is to be constructed. The skin alone is then divided with strong scissors along the line which is to separate the upper from the lower lip. The mucous membrane is next divided along the same line, but not as far outward, the difference in the length of the two incisions being a little less than the thickness of the cheek. The mucous membrane at the outer extremity of the incision is then connected with the skin by a suture, so as to form the new angle of the mouth, and the borders of the upper and lower lip are reconstructed by uniting with the sutures the skin and mucous membrane, after paring thin slices of skin from the upper and lower borders of the wound.

Fig. 953.



Buck's operation for restoration of upper lip.

Cheiloplastic operations are subject to great variety of detail, according to the nature and extent of the deformity, and of the material in the neighborhood which may be utilized for transplantation.

Fig. 954.

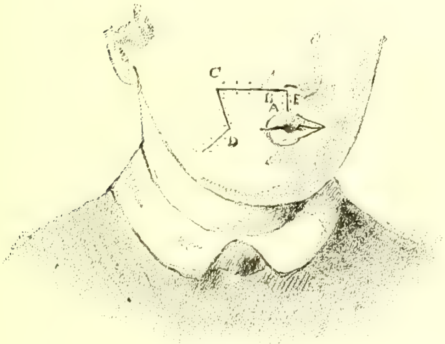
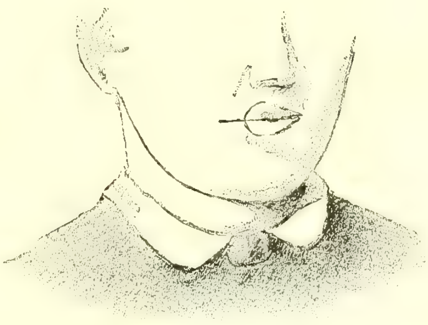


Fig. 955.



Buck's operation for restoration of upper lip.

A number of these operations are illustrated in the Atlas accompanying a work published in 1842, by M. Serre.[1]

I have selected a few of these illustrations, as containing valuable hints for the guidance of surgeons in restoring the lips as nearly as possible to a normal condition after a considerable loss of substance. Fig. 956 represents the manner of removing a morbid growth involving nearly the whole of the vermilion border of the lower lip, by two vertical incisions extending down from the angles of the mouth, and a horizontal incision below the inferior part of the neoplasm. The vertical incisions are extended downwards below the chin, and a quadrilateral flap is dissected from the subjacent parts and drawn up until it comes in contact with the upper lip. The mucous membrane at the upper extremity is united with the skin by fine sutures, so as to form a new vermilion border, and the flap is united on each side with the adjacent integument by pin-sutures, as represented in Fig. 957.

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[1] Traité sur l'art de restaurer les Difformités de la Face, etc. Montpellier, 1842.

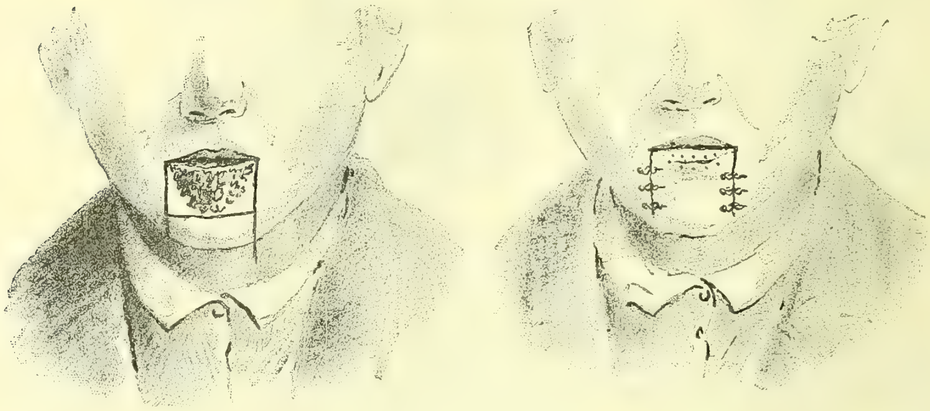


Fig. 956. Fig. 957.

Cheiloplasty of lower lip. (After Serre.)

Fig. 958 represents a tumor involving three-quarters of the vermilion border of the lower lip, and extending upward and outward beyond the left angle of the mouth. The tumor is included between two vertical incisions joined by a horizontal incision below, and two oblique incisions including the angle of the mouth and terminating at an acute angle on the left cheek.

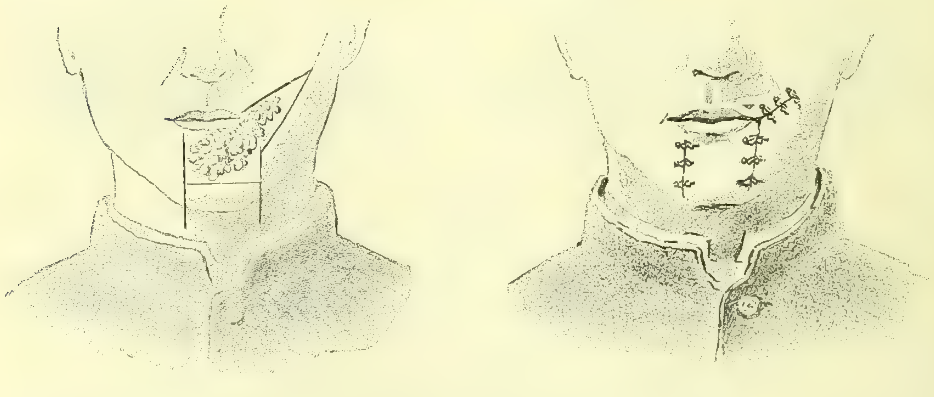


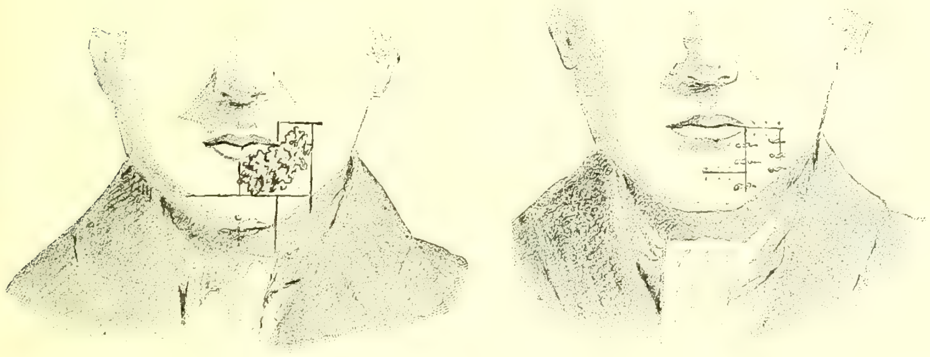
Fig. 958. Fig. 959.

Cheiloplasty of lower lip and angle of mouth. (After Serre.)

Fig. 959 represents the reconstructed mouth with the flaps secured by sutures in their new position.

Fig. 960 represents a tumor in nearly the same situation, removed by vertical and horizontal incisions, which are extended so as to form a transverse flap on the right side, and a vertical flap below the left extremity of the tumor. Fig. 961 represents these flaps drawn into such a position as to fill up the vacant space.

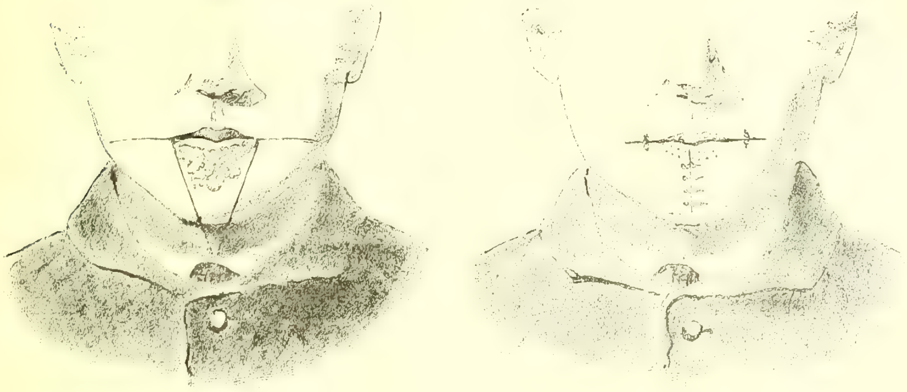
Fig. 960. Fig. 961.



Cheiloplasty of lower lip and angle of mouth. (After Serre.)

Fig. 962 represents a tumor occupying nearly the whole of the vermilion border of the lower lip, included between two incisions extending downward and inward from the angles of the mouth, and meeting at an acute angle on the anterior part of the neck below the chin. From the upper part of these lateral incisions, a nearly transverse incision on each side extends into the

Fig. 962. Fig. 963.

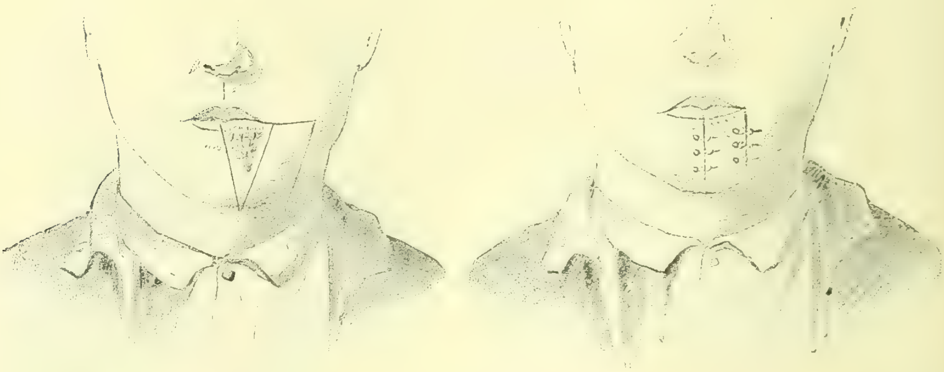


Restoration of lower lip. (After Serre.)

corresponding cheek, and thus two lateral flaps are formed, which are drawn together so as to meet in the median line as shown in Fig. 963.

Fig. 964 exhibits a tumor involving the left half of the vermilion border of the lower lip, included between two incisions meeting at an acute angle below the base of the jaw. To cover the vacant space, a quadrangular flap is cut on its outer side, and drawn towards the median line, where it is fixed by sutures, as shown in Fig. 965.

Fig. 964. Fig. 965.



Restoration of left half of edge of lower lip. (After Serre.)

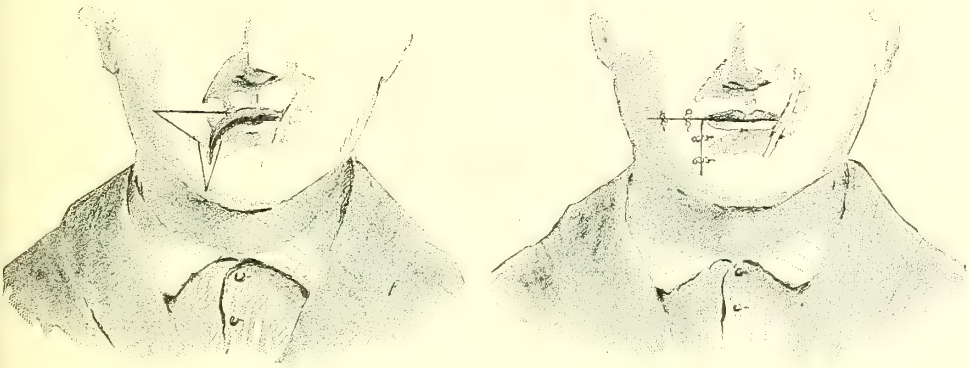
Fig. 966 exhibits a morbid growth, extending from the right commissure of the lips downward and outward, and included between incisions meeting at two acute angles, so as to form two triangular spaces meeting at their bases, and closed by drawing the adjacent integuments together so as to form a transverse and a vertical line of junction as exhibited in Fig. 967.

Fig. 966. Fig. 967.

Operation for growth involving right commissure of lips. (After Serre.)

Figs. 968 and 969 exhibit a similar proceeding for the removal of a distortion of the right angle of the mouth occasioned by cicatricial contraction.

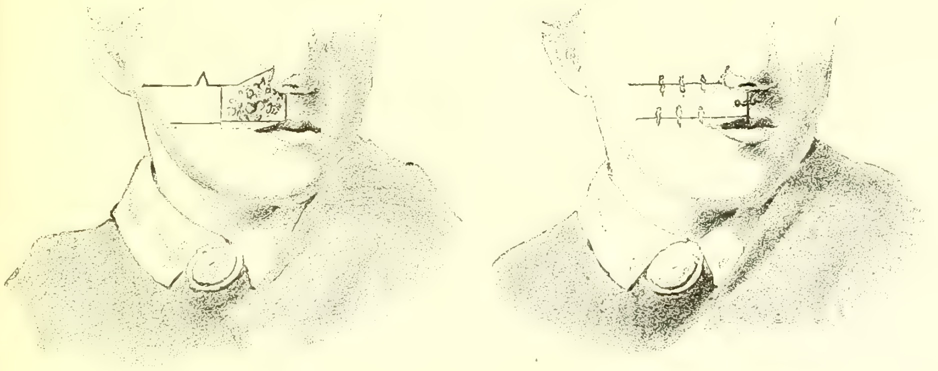
Fig. 968. Fig. 969.



Operation for cicatricial contraction of right angle of mouth. (After Serre.)

Figs. 970 and 971 represent the wound left by removing a tumor of the right half of the upper lip, encroaching on the ala nasi, and the vacant space covered by a horizontal flap with a small triangular prominence adapted to the nasal deficiency.

Fig. 970. Fig. 971.



Restoration of upper lip and ala nasi. (After Serre.)

Fig. 972 represents a mouth contracted to a small ring, enlarged by a transverse incision on each side into the cheek. Fig. 973 represents the reconstruction of the buccal orifice by the attachment of the mucous membrane to the skin on each side, so as to complete the vermilion border of the lips.

A very ingenious method of restoring the symmetry of the lips after a considerable loss of substance of the upper or lower lip, is described by Carl August Burow.[1]

Fig. 972.

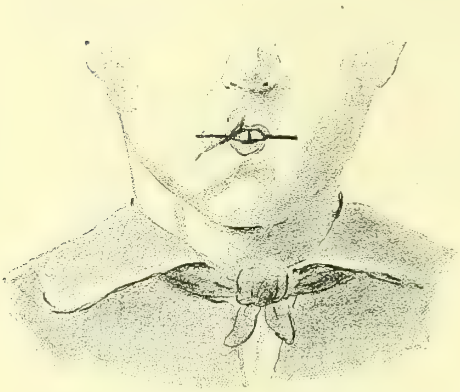
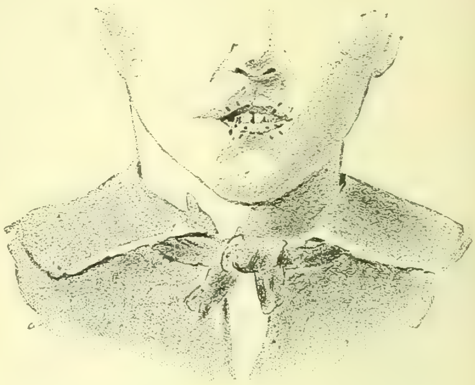


Fig. 973.



Reconstruction of buccal orifice. (After Serre.)

Fig. 974 furnishes a representation of the application of this method to a case of deficiency of the left half of the lower lip. The diseased portion of the lip having been excised by the incisions AB and BC, leaving a triangular chasm ABC, a transverse incision, FD, is extended from the angle of the mouth into the cheek, and from the two ends of this incision the incisions FE and DE are made so as to excise the triangle FED.

Fig. 974.

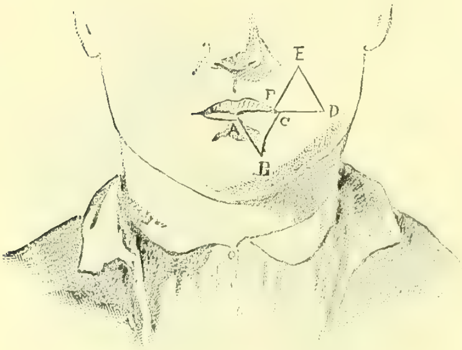
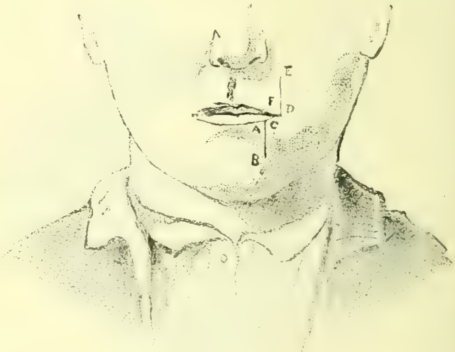


Fig. 975.



Burow's plastic operation.

Fig. 975 represents the reconstruction of the mouth by joining the line AB to AC, and the line EF to ED. This method of operating may be adapted to a considerable variety of deformities of the lips. The principal objection to it is that it involves the loss of a considerable portion of healthy integument. But there are cases in which the symmetry of the lips can be better secured by it than by any other method.

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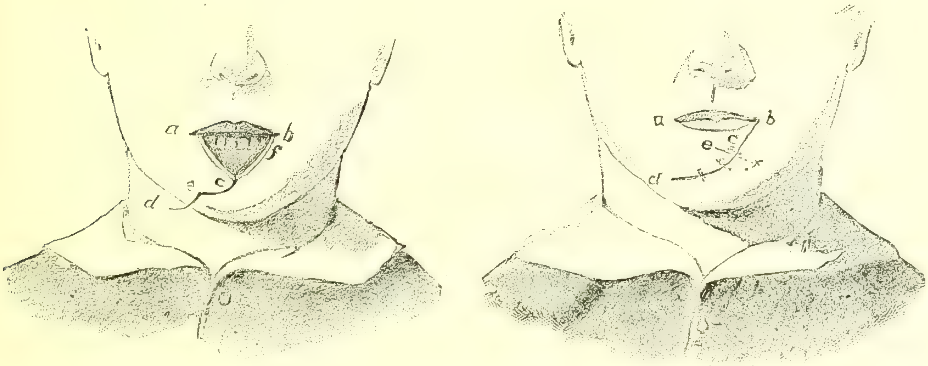
[1] Beschreibung einer neuen Transplantations-Methode (Methode der seitlichen Dreiecke) zum Wiedersatz verlorengegener Theile des Gesichts. Berlin, 1855.

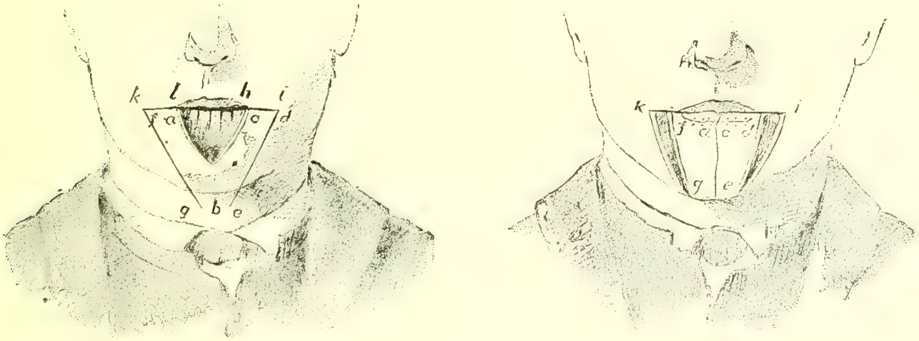
Szymanowski[1] gives illustrations and descriptions of a number of ingenious operations for the removal of deformities of the lips. I have selected a number of these illustrations, and I have no doubt that many useful hints may be derived from their careful study. Fig. 976 exhibits a triangular chasm produced by the excision of a tumor involving the whole of the vermilion border of the lower lip, and a flap of integument on the right side which is designed to be drawn upward and to the left, so as to fill the chasm. Fig. 977 represents the flap secured in its new position by sutures.

Fig. 976. Fig. 977.



Restoration of edge of lower lip. (After Szymanowski.)

Fig. 978. Fig. 979.



Restoration of whole lower lip. (After Szymanowski.)

Fig. 978 represents a somewhat more extensive triangular chasm, the apex of which extends to the chin, and a quadrilateral flap on each side, designed to be joined together in the median line, as represented in Fig. 979, leaving on each side a narrow chasm to be filled by granulation.

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[1] Handbuch des operativen Chirurgie. Braunschweig, 1870.

Fig. 980 exhibits a different mode of forming flaps to close a triangular chasm extending from the free border of the lower lip to the chin. The flaps as seen in the diagram are curved, and terminate above at acute angles, so that when the flaps are brought together in the median line, the integument above their apices can be readily united by sutures without puckering. In many cases, flaps constructed in this way will close the chasm with less disfigurement than when any other method is employed. Fig. 981 exhibits the appearance of the parts when the flaps are adjusted and secured by sutures.

Fig. 980.

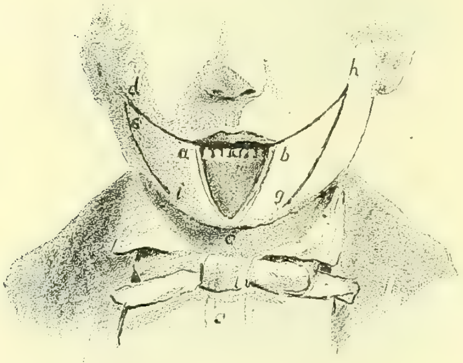
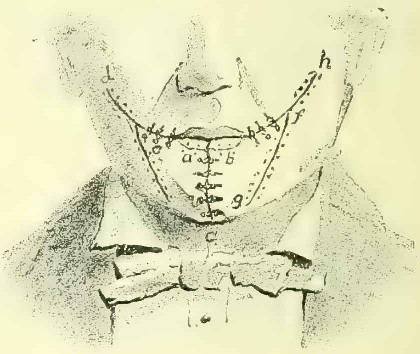


Fig. 981.



Restoration of lower lip by another method. (After Szymanowski.)

Fig. 982.

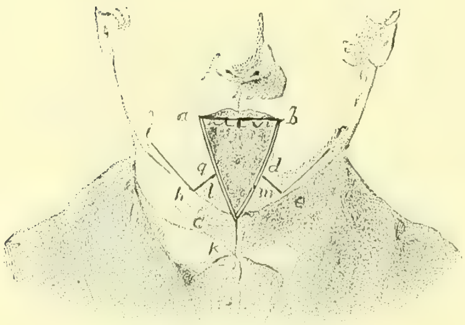
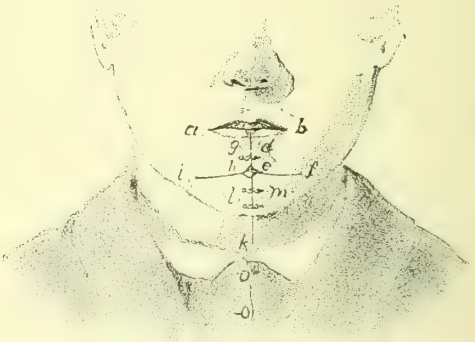


Fig. 983.

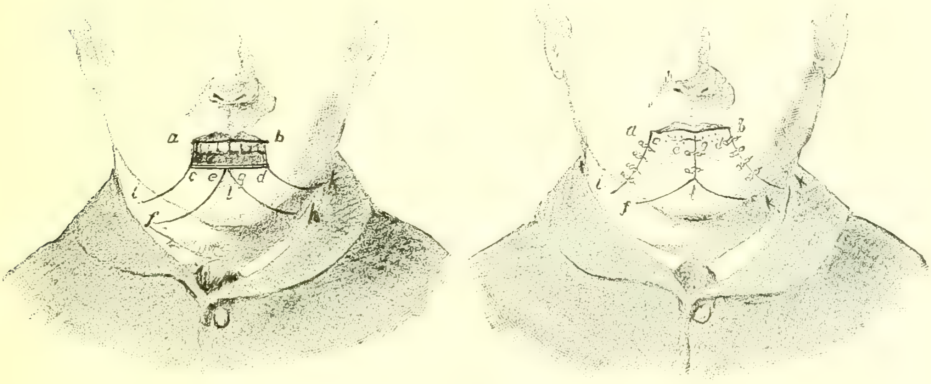


Another method of restoring the lower lip. (After Szymanowski.)

Fig. 982 represents another mode of closing the chasm by lateral flaps on each side, with their bases above towards the cheeks, and their free extremities below. These flaps, as represented in Fig. 983, are turned edgewise so that their free extremities meet in the median line, and the lower part of the chasm is filled by other flaps dissected from the subjacent parts.

Fig. 984 represents a chasm of the form of a parallelogram produced by the excision of the lower lip, and two curved flaps extending below the base of the jaw, and with their upper free extremities separated by a triangular portion of integument which is left above the chin. Fig. 985 represents these flaps as drawn up to form the reconstructed lower lip, and supported by the triangular buttress of integument which was left *in situ*.

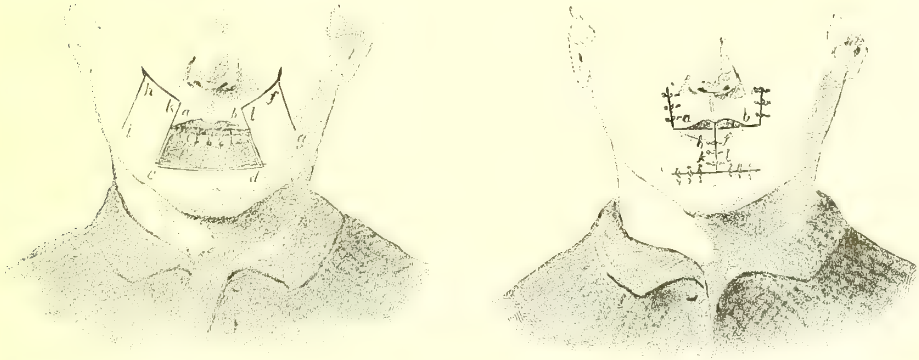
Fig. 984. Fig. 985.



Reconstruction of lower lip. (After Szymanowski.)

Fig. 986 represents a chasm similar to that of Fig. 984, but with vertical flaps on each side, with their free extremities directed upward, and designed to be turned edgewise so that their free extremities shall meet in the median line, as represented in Fig. 987.

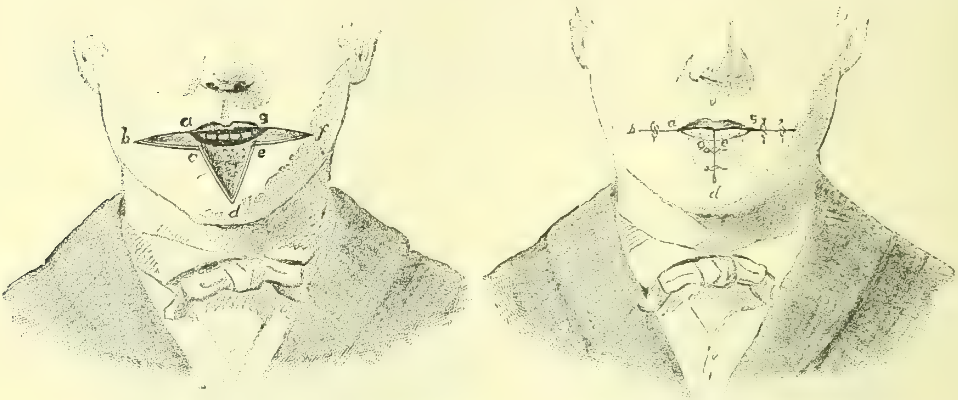
Fig. 986. Fig. 987.



Reconstruction of lower lip by another method. (After Szymanowski.)

Fig. 988 represents a case in which the whole border of the lower lip is destroyed, but in which the loss of substance does not extend far down towards the chin. Three portions of skin are excised, each of the form of a spherical triangle, the middle one with its base upward and its apex towards the chin, while the two lateral triangles have their bases at the commissures of the lips, and their apices directed outwards upon the cheeks. Fig. 989 represents the reconstructed lip, the lateral flaps being brought together in the median line, and at the same time being lifted up by their attachment to the cheeks.

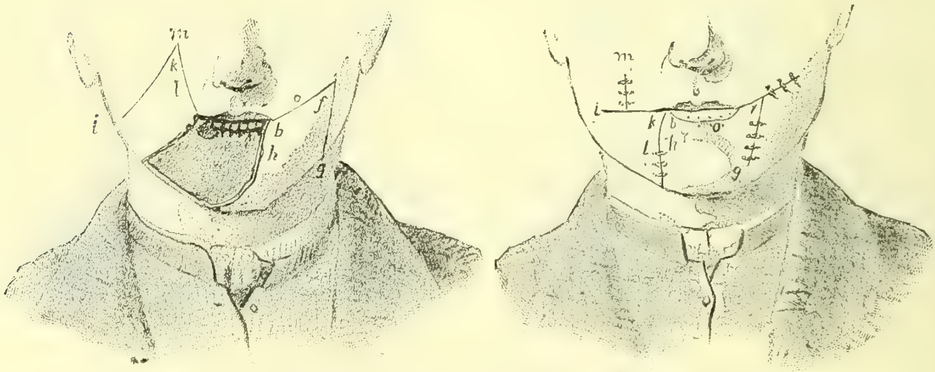
Fig. 988. Fig. 989.



Restoration of border of lower lip. (After Szymanowski.)

Fig. 990 represents a much more extensive loss of substance, involving the whole breadth of the lower lip and the right angle of the mouth. To cover the deficiency, two flaps of unequal size are dissected from the cheeks, the smaller one on the right, above and without the right angle of the mouth, the larger one on the left, chiefly below and without the left angle of the mouth, and extending below the base of the jaw. The reconstructed lip and the lines of union of the flaps are seen in Fig. 991.

Fig. 990. Fig. 991.



Restoration of lower lip and angle of mouth. (After Szymanowski.)

Fig. 992, exhibits a remarkable fissure of the upper lip, in which the sides of the fissure extend in a direct line from the columna nasi to the angles of the mouth. To remedy this defect, a curved incision is carried on each side around the ala nasi, separating the upper extremity of the border of the fissure from the columna, and the flaps thus made are brought together in the median line, in such a manner that the edges of the fissure become horizontal and form the free border of the reconstructed upper lip, as shown in Fig. 993.

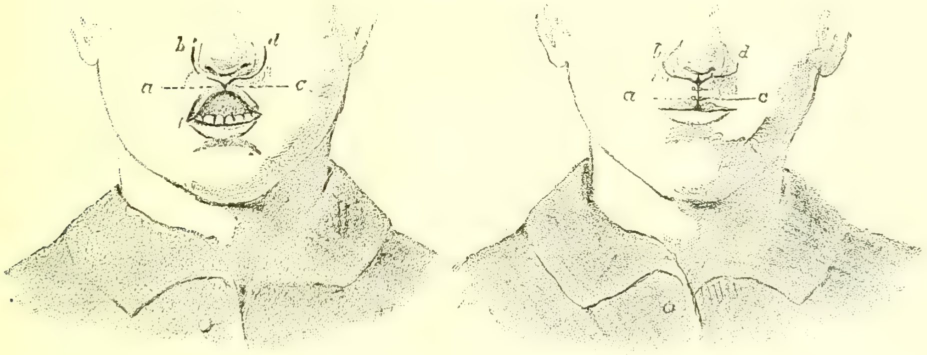


Fig. 992. Fig. 993.

Operation for fissure of upper lip. (After Szymanowski.)

Fig. 994 exhibits a case of destruction of the upper lip throughout its whole extent. Lateral flaps, of the full breadth of the lip, are cut on each side; their outer extremities are curved downwards so as to relieve them from tension; and their inner extremities are then drawn together in the median line, as shown in Fig. 995. Figs. 994 and 995 are altered from Szymanowski's drawings by curving the peduncles of the flaps. This change in the form of the flaps is a matter of great importance in relieving tension, and in securing primary union with a minimum of deformity.

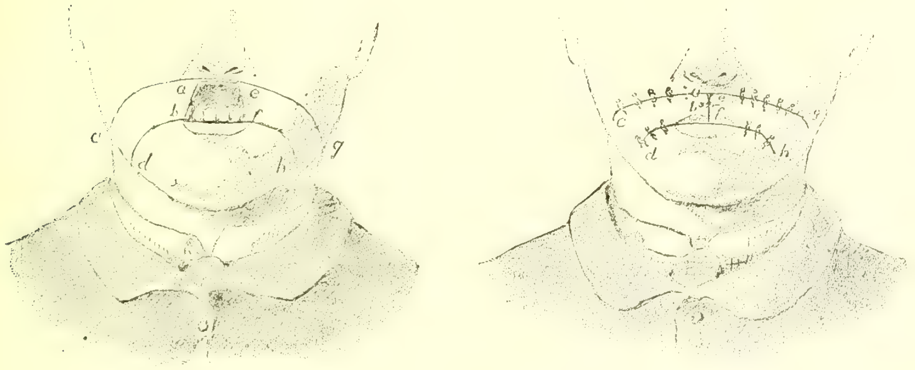


Fig. 994. Fig. 995.

Restoration of upper lip. (Modified from Szymanowski.)

Fig. 996 exhibits a cleft of the upper lip, extending from the angles of the mouth to a point in the median line, one third of the distance from the nose to the incisor teeth. A transverse incision is made above the upper extremity of the cleft, so that the lower border of the lip can be brought down to its normal position, and from the two extremities of this transverse incision vertical incisions are carried up on each side of the nose, and then an oblique, curved incision is made upward and outward on each cheek, and from its extremity another slightly curved incision is made downward and a little outward. These incisions circumscribe a flap on each side, and these flaps are turned downwards and inwards so that their upper extremities meet in the median line, and fill up the space between the transverse incision and the depressed margin of the lip, as shown in Fig. 997. The acute angles at *i* and *k* favor the approximation of the edges of the wound without puckering.

Fig. 996.

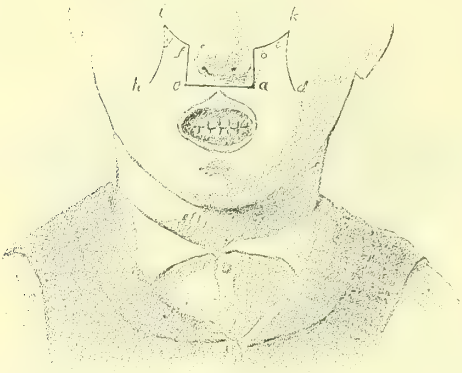
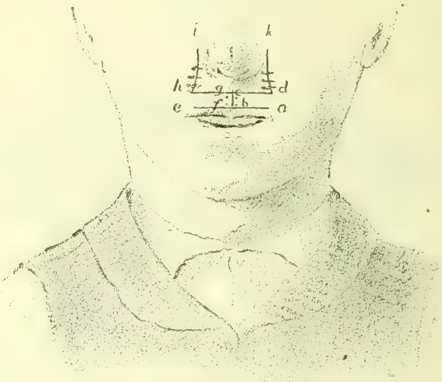


Fig. 997.



Operation for cleft of upper lip. (After Szymanowski.)

Fig. 998 represents the destruction of the whole of the lower lip, and of nearly the whole of the upper lip, only a small portion of its right extremity being preserved. To cover this deficiency, and reconstruct the lips, a transverse incision is made in each cheek along the line which separates the teeth of the upper jaw from those of the lower jaw; another transverse incision is

Fig. 998.

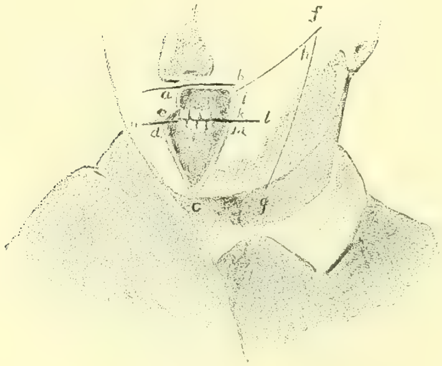
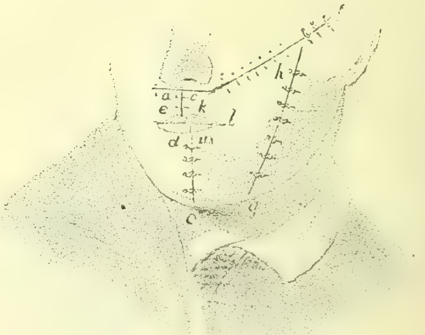


Fig. 999.



Restoration of both lips. (After Szymanowski.)

made on the right side below the ala nasi, and a huge flap is made on the left side, bounded within by the left border of the chasm, above by an oblique line extending upward and outward from the left upper angle of the chasm to a point in front of the left ear, and without by a curved line which extends along the ramus of the jaw below its base to the upper part of the neck. This large flap is drawn across the median line to meet the smaller flap on the right side. The vermilion borders of the upper and lower lips are made by uniting the mucous membrane with the skin, as seen in Fig. 999.

Fig. 1000 exhibits the chasm occasioned by the removal of the right angle of the mouth and the adjacent portions of the upper and lower lips. The chasm represents two triangles joined by their bases near the angle of the mouth, the apex of the lowest triangle extending down toward the right side of the chin, and that of the upper one extending outwards towards the ramus of the jaw. Fig. 1001 shows how the sides of the triangles are approximated to restore the contour of the mouth.

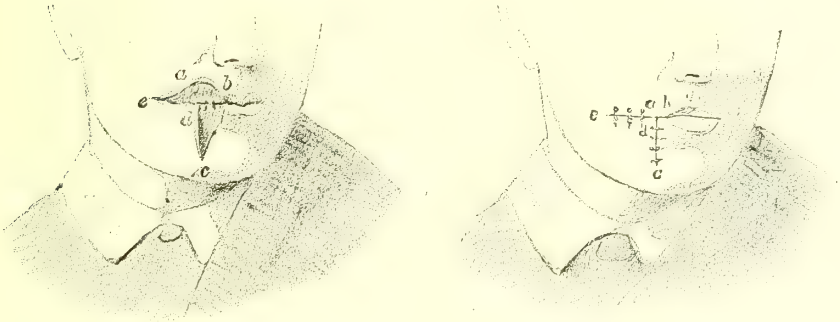


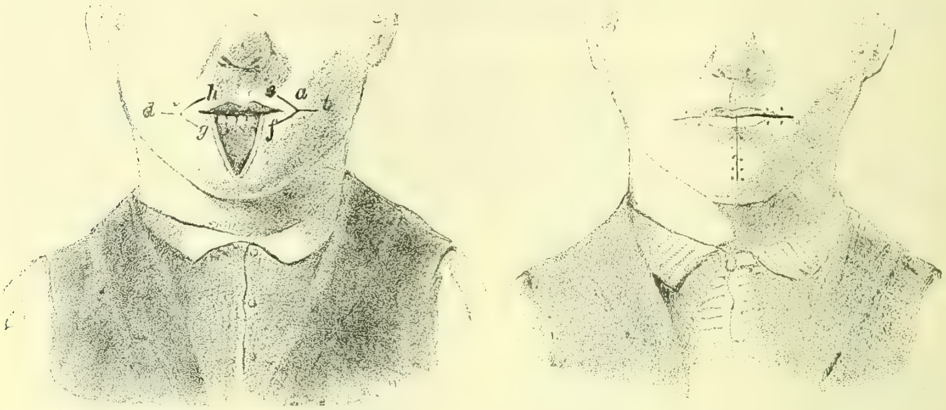
Fig. 1000. Fig. 1001.

Restoration of parts of both lips and angle of mouth. (After Szymanowski.)

Fig. 1002 exhibits the lines of incision by which a diseased mass involving the middle half of the free border of the lower lip has been removed. If the sides of this chasm were simply approximated, the edge of the lower lip would be very much contracted, and the border of the upper lip would appear abnormally full. To obviate this difficulty, and to cause the upper lip to impart a portion of its superfluous border to supply the deficiency of the lower lip, a Y-incision is made transversely a little beyond each angle of the mouth, and when the lateral flaps are joined together in the median line, a portion of the border of the upper lip on each side is made to supplement the border of the lower lip, as seen in Fig. 1003.

Before concluding the subject of cheiloplasty, it may not be amiss to make a few statements with regard to the general subject of plastic operations. The success of these operations depends largely on careful attention to certain minute details. One of the most important matters in this connection is the treatment of cicatricial tissue. None of this tissue should be included in transplanted flaps, as it will almost invariably lead to sloughing of the flap. Cicatricial tissue may be freely incised, and may even be divided into narrow segments, without losing its vitality, if its basal attachments be left undisturbed. An incision may be made through a cicatricial band, and a flap of healthy integument may be attached to it by sutures, and union will take place. In transplanting a flap of integument to fill up a chasm, great care should be taken to secure a sufficient vascular supply to maintain its vitality, by allowing ample breadth to its peduncle, and by including in the flap a sufficient thickness of subcutaneous cellular tissue. The success of a plastic operation depends very much on the absence of tension, and on the freedom with which the flaps are brought into position. When the transplanted flaps are of considerable thickness, and when they traverse an extensive space, they should be held in position by pin sutures extending through nearly their whole thickness. In addition to these deep sutures, fine silken sutures should be employed at short intervals to maintain a close union of the external lips of the wound. When a certain amount of tension is unavoidable, it may be relieved in part by the use of bead sutures, as recommended by Dr. Buck, in his work on Reparative Surgery. For this purpose, silver wire should be passed through the whole thickness of the flaps, entering on one side and emerging on the other an inch or more from their line of union; the end of the wire on one side is passed through a glass bead, and then through a small disk of leather, and tied into a knot, while the other end of the wire is passed through a bead and drawn so as to bring the edges of the wound into close contact, and then twisted over a small piece of wood, such as the end of a friction match. The end of the wire should be left long, to admit of its being readjusted if it should become too tight or too loose. When one or more bead sutures are employed to relieve tension, the edges of the wound should be accurately adjusted to each other by fine black silk stitches. While the sutures are in position, no adhesive plasters, bandages, or compresses, or any other dressings should be employed, but if the parts become inflamed, cooling and astringent lotions may be applied. After the removal of the sutures, the recently united parts may be supported by means of adhesive plasters, or of shreds of lint moistened with collodion.

Fig. 1002. Fig. 1003.



Mode of repairing deficiency of edge of lower lip. (After Szymanowski.)

After the flaps have become perfectly united, if there be at any part a superfluity of tissue, a small portion may be excised, being included between two semi-elliptical incisions, and the edges brought into contact and secured by fine sutures. Under these circumstances, union will take place more rapidly and more perfectly than if similar incisions had been made in parts whose natural relations had not previously been disturbed.

INJURIES AND DISEASES OF THE MOUTH, FAUCES, TONGUE, PALATE, AND JAWS.

BY

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INJURIES OF THE MOUTH, FAUCES, AND TONGUE.

WOUNDS OF THE TONGUE caused by the teeth of epileptics are seldom severe enough to require any special treatment, but bites of the tongue caused by a fall upon the chin or a violent blow beneath the jaw, when the tongue is protruded, are often serious. The hemorrhage may be best arrested by the use of ice, or, in its absence, by exposing the part to cold air, but any serious arterial bleeding should be controlled with a ligature, which, though apt to be soon sucked off, usually sufficiently accomplishes its purpose if tied tightly. When only the margin of the tongue is bitten through, no stitches will be required, but when a large portion of the tip is hanging loose, it will be necessary to put silk sutures deeply into the substance of the tongue, in order to bring the parts into apposition. I have, on more than one occasion, had to pare the edges of a bitten tongue in which this had been neglected, and then bring the parts together again with stitches. Wounds of the tongue by the stem of a pipe or a crochet-needle, held in the mouth, occasionally occur, and a piece of broken tobacco-pipe has been found imbedded in the tongue many months after the accident. In the case of a crochet-needle or fish-hook which may have been accidentally driven into the tongue, it will be necessary to force the barbed point completely through the organ, in order that its removal with cutting-pliers may permit the withdrawal of the shaft of the instrument.

WOUNDS OF THE FAUCES may be due to accident or to surgical interference. Accidental wounds are mostly caused by the forcible thrusting backwards of a tobacco pipe, and are unimportant, unless, as has happened, the stem should have been driven obliquely outwards into the internal carotid artery.[1] In such a case the withdrawal of the stem must lead to fatal hemorrhage, and it may be doubted whether, if the injury could be diagnosed, the fatal event could be averted. A case of deep arterial wound by the point of a parasol, in which the common carotid was successfully tied, is recorded by Mr. Durham,[2] but it was probably some branch of the external carotid which was wounded. The hemorrhage following a puncture of an inflamed tonsil is often severe, and depends upon a wound of an unusually large tonsillar artery; or, possibly, if the puncture has been very deep, the blood may come from the ascending pharyngeal artery. The fear of wounding the internal carotid artery by any reasonable incision is chimerical, and in fatal cases of ligature of the common carotid, for supposed wound of the internal carotid, that vessel has been found intact. Several illustrations of this statement will be found in a list of fifty cases of wound of the throat in which the common carotid was tied, appended to a paper by Mr. Harrison Cripps,[1] in which the author advocates ligature of the external rather than of the common carotid in similar cases.

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[1] See cases by Mr. Vincent (Medico-Chirurgical Transactions, vol. xxix.), and Mr. Charles Moore (Lancet, Sept. 10, 1864).

[2] Holmes's System of Surgery, 3d ed., vol. i. p. 745.

Wounds of the pharynx by bodies swallowed, such as fish-bones, needles, pins, or pieces of grass (Moore), give rise to serious abscesses in the cellular tissue behind the pharynx. In two cases I have known *torticollis* produced by a pin which I was able to extract with a horse-hair probang.

Foreign bodies, such as portions of insufficiently masticated meat, may lodge in the pharynx and give rise to serious symptoms, and even death, by obstructing the windpipe.[2] Unfortunately, in these cases the urgent symptoms are often misinterpreted and the patient thought to be suffering from apoplexy, for the prompt removal of the foreign body with the finger is a sufficiently obvious and simple mode of treatment. A case is recorded by Mr. Pollock[3] in which a set of displaced artificial teeth caused death by being impacted in the pharynx and pressing on the epiglottis; but, on the other hand, Sir James Paget[4] removed a large plate, with nine artificial teeth attached, from the pharynx of an old gentleman *four months* after they had been swallowed.

Tooth-plates may in most cases be withdrawn from the pharynx with ordinary curved forceps; but when they have projecting metal points, these are apt to become entangled in the wall of the pharynx and prevent withdrawal. In these circumstances it will be necessary to open the pharynx, as in two successful cases recorded by Mr. Cock.[5] The foreign body being fixed at the point where the pharynx and œsophagus join, an incision along the inner edge of the left sterno-mastoid muscle, with its centre opposite the cricoid cartilage, will allow of a careful dissection to the inner side of the carotid sheath, until the projecting wall of the pharynx is reached. The gullet having been opened and the foreign body extracted, the opening may be advantageously closed with carbolized catgut sutures.

Diseases of the Mouth and Fauces.

Inflammatory affections of the mouth and fauces may be due to local or constitutional causes. A scald of the mouth from imbibing hot fluids, or hot steam (as not unfrequently occurs in the case of the children of the poor from drinking out of a teakettle), will produce a sodden condition of the mucous membrane of the mouth, with possibly vesication. Inflammatory action supervenes in due course, and may lead to fatal œdema of the larynx and fauces, but in the mouth comparatively little harm will be done except by the local destruction of epithelium, which may be seen forming a dense white membrane closely resembling that found in diphtheria.

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[1] Medico-Chirurgical Transactions, vol. lxi. 1878.

[2] Beale, Pathol. Soc. Trans., vol. iii.

[3] Lancet, April 3, 1869.

[4] British Journal of Dental Science, vol. v.

[5] Guy's Hospital Reports, 3d series, vols. iv. and xiii.

The imbibition of strong mineral acid or of strong carbolic acid, is usually immediately fatal from injury to the stomach, but in cases in which the fluid has been ejected, the mucous membrane of the mouth will be charred, and deep sloughing will ensue.

Stomatitis, or inflammation of the mouth, is a disease of childhood, except when it is the result of the action of mercury upon the system. In badly fed and ill-nourished children, it is common to meet with an inflammatory condition of the mouth (*stomatitis follicularis*), coupled with small vesicles rapidly developing into ulcers. Added to this is commonly found the condition known as "thrush," due to the development of a grayish-white pellicle containing the *oïdium albicans*, a parasitic fungus.

A more important form of the disease is the *stomatitis gangrenosa*, which if unchecked may develop into the formidable *cancrum oris*. Beginning usually in the gum, close to the necks of the teeth, the disease appears as a line of unhealthy ulceration, which rapidly extends along the neighboring gum, and into the sulcus of mucous membrane between the teeth and the cheek. Owing to the destruction of the gums and the extension of inflammation into the sockets of the teeth, these soon become loosened, and drop out; there is a profuse, purulent, offensive discharge, by swallowing which the patient is poisoned, besides being worn out by the irritation and want of food.

The slightest cases, whether of simple or gangrenous stomatitis, are best treated by attention to feeding, and especially to hygiene; and locally by the use of the solid nitrate of silver, and the constant application of the glycerine of carbolic acid, combined with the internal administration of chlorate of potassium, which seems to be almost a specific remedy in these cases. The more severe cases of gangrenous stomatitis must be arrested by the application of strong nitric acid or the actual cautery—by preference Paquelin's thermo-cautère—while the patient is under the influence of chloroform.

Cancrum oris[1] is thought by some authors to be a separate disease, and to originate in the cheek, which rapidly becomes gangrenous and sloughs away, causing a hideous deformity, and rapidly proving fatal in the majority of cases. The treatment is the same as for the more severe forms of gangrenous stomatitis, but the disease is apt to leave terrible deformity in cases which recover, and to lead to permanent closure of the jaws by cicatrice

Tonsillitis, or acute inflammation of the tonsils, commonly results from exposure to cold in the case of delicate young people who have susceptible throats. Towards evening the throat feels swollen and painful, and both speech and deglutition become difficult, the voice having a peculiar, thick tone, which is very characteristic. On inspection, the fauces will be seen deeply injected, and the tonsils swollen and bulging both towards the median line and behind the anterior pillars of the fauces. There is great tenderness in the submaxillary region and behind the jaw, and occasionally acute pain in the ear, from extension of inflammation along the Eustachian tube. There is, besides, considerable fever, the temperature rising three or four degrees, and the tongue being coated with a white fur; but the pulse, though rapid, has little force, and is very compressible. In from twelve to twenty-four hours, and either with or without a rigor, matter forms in one or, seldom, both tonsils; and if not relieved gives rise to great distress from the embarrassment caused to the breathing, the patient sitting up in bed and constantly hawking up viscid mucus, until at last in some straining effort the abscess bursts, when immediate relief with rapid convalescence follows.

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[1] See Vol. II. page 308.

[2] Vide infra.

In the premonitory or early stage, a mustard emetic often acts as a charm and produces immediate resolution; but, failing thus, recourse may be had to warm inhalations, the application of hot poultices below the ear, and the administration of belladonna internally, in small and frequent doses, coupled with plenty of liquid food. Salicylate of sodium has also been held to act as a specific in these cases. An early puncture of an inflamed tonsil is much to be recommended if the surgeon will use a bistoury covered except for a quarter of an inch from the point, and will thrust it boldly through the soft palate where it is made prominent by the tonsil. The hemorrhage should be encouraged by gargling with hot milk and water, and much greater relief will thus be given than by the application of leeches externally. The same method should be adopted in opening an abscess in the tonsil, and thus all risk of doing damage to important structures will be avoided.

A more chronic form of tonsillitis is familiar to residents in hospitals under the name of "hospital sore-throat," and is met with among persons exposed to bad air, particularly if tainted with sewer-gas. It consists in a subacute inflammation of the tonsils, with injection and ulceration of the fauces, sometimes going on to abscess, but more frequently subsiding if the patient is put upon a stimulant and tonic plan of treatment, and removed from the depressing influences to which he has been exposed. The occurrence of frequent sore-throats in a household should direct immediate attention to the condition of the drainage, and to the probable escape of sewer-gases into the house.

PHARYNGITIS.—Acute inflammation of the pharynx may occur in conjunction with tonsillitis, or alone, and its chief symptom is the difficulty in swallowing. The disease ends ordinarily in resolution, but may occasionally lead to suppuration in the cellular tissue behind the gullet, thus causing a post-pharyngeal abscess. The bulging forward of the posterior wall of the pharynx by an elastic swelling which impedes deglutition and may interfere with respiration, clearly marks the case,[1] and a puncture in the median line will readily evacuate the pus. It should not be forgotten that post-pharyngeal abscess is often connected with caries of the cervical vertebræ, in which case it has been proposed by Mr. Cheyne to open the abscess externally with antiseptic precautions.

ERYSIPELAS occasionally attacks the fauces and pharynx, and appears to lead to complete temporary paralysis of the muscles, so that not only is deglutition suspended, but it is impossible to excite reflex action in the muscles by irritating the throat mechanically. The affection is a very serious one, and likely to prove rapidly fatal from depression of the vital powers, both by the poison and by the want of food, unless ample nourishment be administered by the rectum until the power of swallowing is restored. A much more chronic form of paralysis of the throat is that following diphtheria, but here it is the palate which is principally affected, the voice being thick for weeks.

HYPERTROPHY OF THE TONSILS is common in children and young persons of a strumous diathesis, and in rachitic patients is apt to lead to the deformity known as "pigeon-breast," from interference with the full expansion of the lungs. The thick speech, open mouth, and stertorous breathing, which in sleep develops into sonorous snoring, are sufficiently marked in extreme cases;

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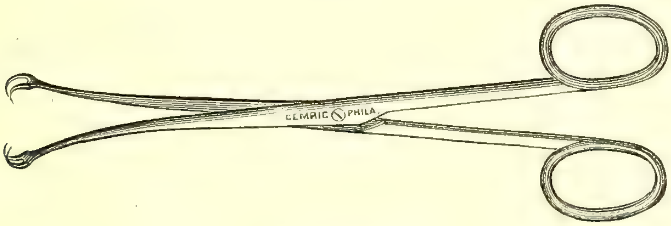
[1] C. Fleming, Cases Occurring in Children, Dublin Journ. of Med. Science, vol. xvii.

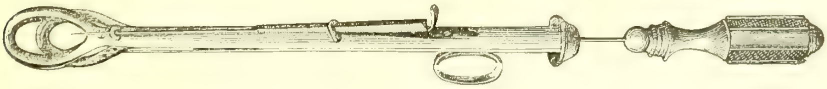
whilst in milder cases the constant tendency to sore throat and the general failure of health and strength without obvious cause should direct attention to the tonsils. On inspection, the tonsils will be seen as large, white, glistening masses, often meeting in the middle line, and presenting yellow spots due to inspissated mucous secretion. Hypertrophied tonsils may project into and down the pharynx, but can never reach up to and obstruct the Eustachian tubes; the deafness so commonly found in these cases is due to the generally congested condition of the mucous membrane, which is relieved by the removal of the glands. The application of local styptics in the form of a solution of nitrate of silver (gr. x to f℥j), or the glycerine of tannin; the use of catechu or krameria lozenges, or the employment of a spray of sulphate of zinc (gr. x to f℥j), are all useful in slight cases by keeping the disease in check, while the patient's health is improved by sea air and tonics. In severe cases, removal of the projecting portion of the tonsil is the best remedy, and is much less painful and infinitely more satisfactory than drilling the tonsil with a sharp stick of nitrate of silver, or caustic potassa, as has been recommended. The simplest form of guillotine, used with a pair of volsella forceps (Fig. 1004), by which the tonsil can be drawn thoroughly into the ring with the opposite hand, is preferable to the complicated guillotines fitted with a fork, which are apt to get out of order, and which require considerable practice for their successful employment. The patient being seated in a good light, with the head thrown back and the hands held by assistants, the guillotine can be slipped into the mouth, which it immediately gags. The forceps then grasping the tonsil through the ring of the guillotine, draws it well forward, and a sharp movement of the thumb drives home the blade of the guillotine and cuts a large portion off. Without withdrawing the guillotine, it is turned round and the other tonsil is similarly treated by changing hands, before the little patient has really time to cry. It is quite sufficient to remove a large portion of a tonsil, and any attempt to remove the whole is likely to be followed by sharp bleeding; but at the same time it is necessary to pull the piece to be removed well into the ring, so as to avoid notching the pillar of the fauces, from which the mucous membrane is continued directly on to the tonsil, occasionally holding it very firmly. Ordinarily, the sucking of ice for a few minutes staunches all bleeding, but if not, the bleeding surface, and that only, should be painted with the solution

Fig. 1004.



Volsella forceps.

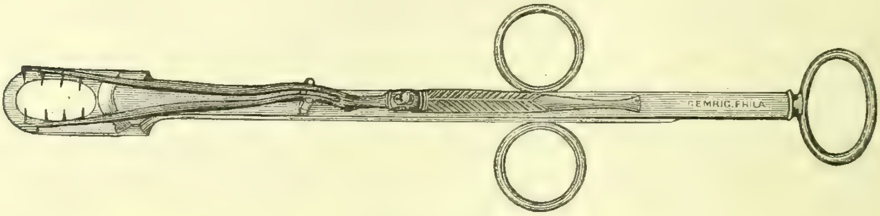
Fig. 1005.



Fahnestock's tonsillotome.

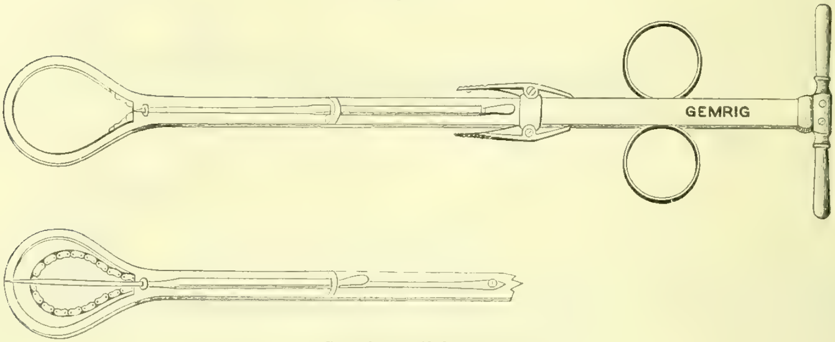
of the persulphate of iron. After removal of the tonsils, ice may be sucked for a few hours, and a warm poultice under the jaw gives great comfort. Care should be taken to give food cool enough to be easily swallowed, and for a few days hard substances, such as crusts, should be avoided. [Figs. 1005 and 1006 represent convenient tonsil guillotines, devised respectively by the late Dr. Fahnestock and Dr. Billings, U. S. A. Fig. 1007 illustrates the tonsil *écraseur* employed by Prof. Gross.]

Fig. 1006.



Billings's tonsillotome.

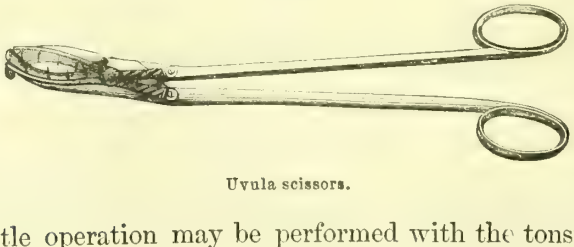
Fig. 1007.



Gross's tonsil *écraseur*.

Hypertrophy of the uvula may be met with in the same class of patients as hypertrophied tonsils, the whole uvula being swollen from over-development of the adenoid tissue contained in it. This must not be confounded with the œdematous uvula due to inflammation, and commonly found in any acute inflammation of the throat. A more common form is the elongated uvula found in persons of relaxed habit, who suffer from irritable throat and constant cough, the result of the irritation of the fauces by the uvula. Astringent gargles may be usefully employed in such cases, but if obstinate, these should be treated like those of chronic hypertrophy, by abscission. This little operation may be performed with the tonsil guillotine, or more simply with scissors, which must be very sharp at the edge but blunt

Fig. 1008.



Uvula scissors.

at the points. The uvula should be caught with a pair of hooked forceps to prevent its being swallowed, and will be found thicker on section than might have been anticipated. [A convenient form of uvula scissors is represented in Fig. 1008.]

ULCERATION OF THE TONSILS of a superficial character is common in inflammatory affections of the throat, and the ulcers are often covered with aphthous patches in patients whose vitality is low. The deep, excavated ulcer of the tonsils, nearly circular in shape and covered with a thin gray slough, is symptomatic of secondary syphilis, and will only yield to constitutional treatment.

Irregular, excavated ulcers presenting a yellow slough, seen upon the uvula and soft palate, or on the posterior wall of the pharynx, are almost always due to tertiary or inherited syphilis, and will heal rapidly under the administration of iodide of potassium in full doses.

As the result of this form of ulceration, adhesions of the soft palate to the pharynx, with narrowing of the pharynx and nasal intonation, owing to the shutting off of the nose, are occasionally met with. Interference with the cicatrices is ordinarily to be avoided, as no good result is likely to follow the division of the adhesions between the palate and pharynx; but where the cicatrization leads to narrowing of the pharynx, division, and subsequent dilatation with bougies, may be advantageously undertaken.[1]

TUMORS OF THE TONSILS, as distinguished from glandular hypertrophy, are rare. In general *lymphadenoma* of the neck, the tonsils may be similarly affected, and may in the later stages ulcerate, as in a lad of seventeen under the author's care. A few instances of distinct *fibro-cellular* tumor of the tonsil have been met with, one of the most recent being that recorded by Mr. Fitzgerald,[2] Surgeon to the Melbourne Hospital, which occurred in a boy of fifteen, and had been present four years, gradually blocking up the fauces. It was successfully removed, and was of irregular, ovoid form, distinctly encapsuled and lobulated. "Its measurements were: Length 2¼ inches; breadth 1¾ inches; thickness 1½ inches. Under the microscope, sections were found, unless very thin, to have a confused fibro-cellular appearance, not cleared up at all by acetic acid. When traced out, the growth was found to consist of small cells, rounded, oval, or spindle-shaped; the spindles, as a rule, were nucleated, and the round cells destitute of nuclei." According to Butlin, round-celled *sarcoma* is the most common of all malignant tumors of the tonsil.

Cancer of the tonsil is rare; it may be primary, in which case it is encephaloid, or more rarely scirrhous; or secondary, from extension of epithelioma from the tongue and pillars of the fauces.

Cases of encephaloid cancer of the tonsils in connection with development of cancer in the lymphatic glands of the neck and in the spleen, have been recorded by Carswell, Sydney Jones, and Moxon; such cases are clearly beyond surgical treatment, but when the disease is confined to the tonsil it has been successfully removed.

Mr. Poland,[3] in an exhaustive article upon "Cancer of the Tonsil Glands," shows that the diagnosis of cancer in the early stage is very difficult, it being confounded with chronic hypertrophy or syphilitic gumma. Its rapidity of growth and tendency to involve surrounding structures, including particularly the lymphatic gland at the angle of the jaw, will afterwards serve to distinguish its nature. Removal of portions of the growth by the knife, wire-snare, and *écraseur*, have given unsatisfactory results in the hands of several surgeons, and, if any operation is resorted to, total extirpation of the tonsil should be performed. This operation, though said to have been employed by Langenbeck and Hueter, in 1865, was first described by Dr. Cheever,[1] of Boston, who performed it successfully in 1869, and again in 1878.[2] In both cases, the operation was done through an external incision below the angle of the jaw; and in the second case, the jaw was divided and turned up so as to gain sufficient room without dividing the digastric, stylo-hyoid and stylo-glossus muscles, as had been done in the first case. In both instances the tonsil, when reached by dividing the superior constrictor of the pharynx, was enucleated with less trouble and hemorrhage than might have been anticipated.

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[1] See a Case of Extreme Pharyngeal Stenosis, with *résumé* of subject, by Smith and Walsham. Medico-Chirurgical Transactions, vol. lxiii. 1880.

[2] Australian Medical Journal, September 15, 1880.

[3] British and Foreign Medico-Chirurgical Review, April, 1872.

Dr. Cheever's first patient was lost sight of; in the second case the history may thus be summarized. The primary growth began in the tonsil in August. Lymphatic poisoning occurred, and a bubo formed, in November. The tumor and the bubo were removed by the knife, early in January. Early in February, a second bubo had formed and was removed. In March, the original growth was sprouting again, and was twice burnt away, the bubo not recurring. In May, the pharyngeal tumor was larger than ever, and the bubo was recurrent in an enormous growth. As Dr. Cheever remarks, "the question remains whether, in view of such rapid and persistent recurrence as in the second case, it is worth while to interfere with cancer of the tonsil at all by operation."

In Dr. Cheever's second case, and also in Mr. Fitzgerald's case of fibro-cellular tumor, already described, tracheotomy was done, and the upper aperture of the larynx was plugged to prevent the entrance of blood into the lungs; and it would appear that if this were effectually done, enucleation of the entire growth from within the mouth might be fairly attempted, the diseased lymphatic gland being dissected out separately. Mr. Fitzgerald,[3] indeed, says that, had he known as much as he did afterwards, he would not have made an incision through the cheek, "for after free division of the muscles that bind the lips to the bone, the mouth can be opened to almost any extent that may be required."

In October, 1882, Mr. Golding-Bird and Mr. Clement Lucas, of Guy's Hospital, communicated to the Clinical Society of London cases of epithelioma of the tonsil, removed by the former gentleman from the outside, by Cheever's operation, and by the latter from within the mouth, portions of the soft palate and tongue being at the same time taken away. The results, though not leading to a permanent cure, were encouraging.

Follicular disease of the pharynx is commonly met with as an accompaniment of chronic glandular laryngitis, or *dysphonia clericorum*. The pharynx and fauces are seen to be injected and roughened, owing to hypertrophy of the glandular structures of the mucous membrane. The patient complains of dryness of the throat, and is constantly clearing it, and hawking up small quantities of viscid mucus. The hoarseness of the voice after use for a short time is a marked feature of the disease, and depends upon a similarly congested condition of the laryngeal mucous membrane. In slight cases, much good may be done by proper elocutional instruction, and particularly by teaching the patient to use his lips and tongue rather than his throat in vocalizing. The use of soft astringent lozenges (catechu or rhatany), which are to be slowly sucked at intervals, and the use of a spray with a solution of sulphate of zinc (gr. x to f℥j), night and morning, will effect much good. In more confirmed cases, the application of a strong solution of nitrate of silver (gr. xxx to f℥j), with a brush, or painting with the tincture of iodine or solution of the perchloride of iron, will be necessary, combined with attention to the general health; but the improvement is always slow, and the remedies must be varied to suit individual cases.

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[1] Surgical Cases, Boston, 1869.

[2] Boston Med. and Surg. Journal, August 1, 1878.

[3] Loc. cit.

TUMORS OF THE PHARYNX are of rare occurrence, and usually of congenital origin; they are mostly pendulous, with a narrow neck. The most remarkable case known is one in which a fatty tumor, now in the museum of the Westminster Hospital, occurred in an old man whose history is recorded by Mr. Holt.[1] Here the pedicle was attached to the epiglottis, so that when the tumor was projected into the mouth the patient was suffocated. Other cases in which smaller pedunculated growths have been successfully removed, are recorded, and in any case of difficulty from impending asphyxia, the operation of laryngotomy would relieve all embarrassment during the removal of the tumor.

A pulsating tumor of the pharynx may be due to an aneurism of the *internal carotid artery*, as in cases recorded by Porter and Syme; and Mr. Barnes,[2] of Bolton, has recorded a case of pulsating tumor of the back of the pharynx, in a woman aged seventy-three, in which the pulsation was entirely arrested by pressure upon the *external carotid.*

DISEASES OF THE TONGUE.

TONGUE-TIE is a common congenital affection, but more often imagined by the mother or nurse than actually present. Any slight difficulty in sucking, soon after birth, or in talking at a later period, is apt to be put down to "tongue-tie," and though in some cases the frænum is shorter, and extends nearer the tip of the tongue, than in others, it may be doubted whether, except in extreme examples, it ever really interferes with the movement of the organ. I have, however, recently had to divide the frænum in a young man of twenty-eight, whose speech was certainly interfered with. The operation of division is very simple if a blunt-pointed pair of scissors be used, and if the points be directed downwards so as not to injure the tongue itself, or the ranine artery, which may be protected with the fingers, or with the split handle of a director. A small snip is quite sufficient, and the point of the finger may tear the frænum a little farther if necessary.

RANULA is the term applied to cysts beneath the tongue, but these vary considerably in character. The simplest is a thin-walled cyst having a bluish look, and containing clear mucus. This is due to the obstruction and dilatation of one of the numerous mucous follicles of the floor of the mouth, and never to dilatation of the Whartonian duct of the submaxillary gland, which does not undergo dilatation except when its orifice is obstructed, as sometimes happens, by a salivary calculus. Occasionally a ranula is multilocular, a second cyst lying behind the superficial one.

The treatment consists either in snipping out a piece of the cyst wall with scissors, or in passing a fine seton through the cyst. The seton may be introduced with an ordinary curved needle, and should be of fine silver wire, the ends of which can be twisted, and will lie under the tongue without absorbing putrid material, as would be the case with silk. As a rule, the wire does not cut its way out, and will require removal when the cyst has become obliterated.

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[1] Path. Soc. Trans., vol. v.

[2] Lancet, October 30, 1875.

A rarer form of cyst is the *congenital cyst* of the floor of the mouth, which contains inspissated, sebaceous material, closely resembling putty in appearance, and having an offensive, cheesy odor. Being of slow growth, it seldom gives trouble until early adult life, when an unsightly swelling below the chin is noticed externally, and the tongue is pushed up so as, in extreme cases, to interfere with speech.

This form of cyst is confined to the floor of the mouth, but often has a portion reflected around the posterior edge of the mylo-hyoid muscle, and presenting in the digastric triangle. This fact makes the treatment very difficult, as graphically described by Sir Wm. Fergusson,[1] who met with two cases of the kind, one of which he treated by excision, and the other by inducing suppuration in the cyst. In one case I succeeded in removing the cyst through the mouth, after dividing the mylo-hyoid so as to allow of the withdrawal of the portion superficial to the muscles. Should removal not be feasible, the use of a seton, passed from below the jaw through the mouth, after evacuation of the contents, would probably set up sufficient action to produce a cure. The diagnosis of these cases is always obscure, and they are usually mistaken, until opened, for examples of ordinary ranula.

Inflammatory swelling beneath the tongue, leading to the formation of pus which is apt to find its way between the muscles of the throat, may arise from abscess connected with a tooth, and should be opened early

Hypertrophy with prolapse of the tongue, or macroglossia, though usually a congenital affection, is not invariably so. In some of the recorded cases it appears to have been the result of inflammation occurring in early life, and in one case to have followed the application of a leech. It has been regarded by some surgeons as primarily a prolapse due to deficiency of muscular power, and by others as an hypertrophy leading to prolapse by the weight of the organ; and undoubtedly, in the later stages, the whole organ is enormously enlarged and hangs out of the mouth. In Dr. Humphry's[2] case, in a girl aged eleven, the prolapsed portion of the tongue measured from the upper lip to the tip three and one-half inches, and the circumference of the widest part of the organ was six and one-half inches. The papillæ were greatly enlarged and separated by deep clefts, but no record is given of the condition of the portion removed. Mr. H. Arnott[3] has, however, recorded a case in which there was actual hypertrophy of the muscular substance, as well as enlargement of the bloodvessels and lymphatics, and thickening and induration due to inflammation. In addition to the discomfort caused by the prolapse, in all the recorded cases an alteration in the position of the teeth and alveolus of the lower jaw, due to the constant pressure of the tongue, has been observed. In the treatment of this affection, pressure by bandaging and the use of styptics seem to have given good results in some cases, and Syme[4] speaks highly of the use of a solution of sulphate of copper (℈j to f℥j). Failing to get relief in this way, removal of the protruding portion with the knife, as in Syme's and Humphry's cases, or with the *écraseur*, as in Erichsen's, offers the only method of treatment available.[5] In the case of an idiot boy, aged ten, recently under my care, with macroglossia of congenital origin, I removed the anterior portion of the tongue by a

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[1] System of Practical Surgery, p. 514.

[2] Medico-Chirurgical Trans., vol. xxxvi.

[3] Path. Soc. Trans., vol. xxiii.

[4] Observations in Clinical Surgery. 1861.

[5] List of cases in F. Clarke's Diseases of the Tongue, p. 72.

V-shaped incision, bringing the two sides together with stitches; but these soon cut through, and the result, though eventually satisfactory, was not better than that gained by the simpler method.

Atrophy of one side of the tongue is never a congenital affection, but the result either of cerebral disease or of injury to the hypoglossal nerve, as in a case of aneurism of the external carotid artery, recently under my care, in which the nerve was stretched and atrophied.[1] Sir James Paget[2] has recorded a case in which removal of necrosed bone from the skull relieved the nerve and led to restoration of the tongue, but this is a favorable result which can seldom be anticipated.

Nævus of the tongue is another congenital affection occasionally met with. If superficial it may be treated with nitric acid, the tongue being previously dried and held out of the mouth with a towel so as to prevent injury to the surrounding parts. In more extensive nævi, the application of a ligature, which must be passed into the substance of the tongue and tied very firmly, is the best mode of treatment.

Congenital Tumor of the Tongue.—A very rare form of congenital tumor of the tongue is recorded by Dr. Hickman[3] as occurring in a new-born child, who died a few hours after birth from suffocation induced by the tumor. Immediately in front of the epiglottis was a tumor projecting half an inch from the surface of the tongue, and measuring three-quarters of an inch by one-half inch. It proved to be an hypertrophy of the normal racemose *glandular* structures of the part. Congenital *fibro-cellular* tumors of the tongue are occasionally met with, and, being usually pedunculated, are easily removed. Mr. F. Mason has recorded two examples of the kind, which were allowed to remain *in situ* till adult life.[4]

Lymphangeioma is a very rare congenital affection of the tongue, and is a variety of hypertrophy in which the lymphatics are principally affected. In 1876, I had a young woman aged twenty-three under my care, suffering from this affection, the tongue being enlarged and indurated so as to interfere with speech, but not being prolapsed, and the surface being tuberculated and marked with whitish lines which were evidently enlarged lymphatics. With the hope of producing some effect I passed setons into the tongue, the only result of which was to set up severe inflammation with great temporary distress of breathing, but without any permanent benefit.

Glossitis, or inflammation of the tongue, in the acute form, is an affection rarely met with at the present time, and then is apparently of spontaneous origin. In former days, when the administration of mercury was ordinarily pushed to salivation, the occurrence of glossitis was common, and the swollen tongue protruding from the mouth was looked upon as a proof of successful treatment. As some individuals seem to be peculiarly liable to be rapidly affected by small doses of drugs, it may be well to bear in mind that iodide of potassium and its allies, no less than mercury, may rapidly induce salivation. The swollen, œdematous condition of the tongue in glossitis, may interfere with respiration sufficiently to demand tracheotomy, but as a rule the inflammation rapidly yields to leeching, or to a free incision on each side of the median line.

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[1] Medico-Chirurg. Trans., vol. lxvi.

[2] Clinical Soc. Trans., vol. iii.

[3] Pathological Society's Trans., vol. xx.

[4] Ibid., vols. xv. and xviii.

In milder cases, the use of chlorate-of-potassium and borax gargles, and the free purgation of the patient, will give relief.

Abscess of the Tongue.—Abscess is not unfrequently the result of glossitis, and should be opened as soon as the presence of matter can be detected. In all inflammatory affections in which the tongue is protruded beyond the jaws, the effects of the presence of the incisor teeth upon the organ must be borne in mind, for a deep groove is apt to be cut in the under surface of the tongue by the teeth, and thus the swelling and œdema are increased. The teeth may be conveniently guarded by a metal or gutta-percha shield, and, if necessary, a support for the tongue may be easily adapted to such a contrivance.[1]

Gummata of the Tongue.—Closely resembling abscess, since in its later stages it breaks down and contains fluid, is the *gumma* due to tertiary syphilis. Situated near the base or in the centre of the tongue, gummata or muscular nodes slowly increase in size without pain, and then, when the patient has got out of health from the syphilitic poison in his system, they rapidly soften and discharge, leaving deep excavated ulcers.[2] A very similar nodule occurring in the tongue of a strumous child, and running much the same course as a gumma, would by some surgeons be considered tubercular in its origin, but it may be doubted whether most of the recorded examples are not cases of inherited syphilis. The occurrence of *fibro-cellular* or *fibroid tumors*, or of *scirrhous* or *medullary cancer*, in the substance of the tongue, is extremely rare, and as it is impossible to diagnose their nature in an early stage, it is safer to look upon all tumors of the substance of the tongue as gummatous, and to treat them with full doses of iodide of potassium. The great majority will be found to disappear rapidly under this treatment, and certainly no harm will be done by the drug in cases of other forms of growth, which are not amenable to its influences.

Chronic glossitis, leading to serious alterations in the superficial structures of the tongue, may be due simply to too stimulating food or drink, or, much more frequently, to the over-use of tobacco. It may also depend upon syphilis, or may be caused by prolonged mercurial treatment. In the early stage, the tongue is reddened and irritable, being much more sensitive than in health, and, possibly, patches of similarly affected mucous membrane may be found in the cheeks. If unchecked, patches of white, hypertrophied epithelium will be formed over the most irritable spots, and these may be thrown off from time to time, constituting the so-called *psoriasis linguæ*.

The treatment of this chronic form of glossitis consists in removing all sources of local irritation, and in attending to the general health. Frequent painting with a five-grain solution of chromic acid, in the non-syphilitic forms, and with a two-grain solution of bichloride of mercury in the syphilitic forms of the disorder, seems to be useful, combined with the use of demulcent lozenges, slowly sucked.

A more serious result of chronic glossitis is the formation of a permanent *white patch* (*leucoplakia*, *leucoma*) in which destruction of the papillary structure is brought about with more or less infiltration of granulation-cells. These patches may remain quiescent for years, and may then develop true epithelioma, and they are therefore always causes for anxiety and watching, with a view to early operative interference should any growth begin to develop. It is remarkable, as pointed out by Hutchinson, that we do occasionally see patches on the tongue and cheeks in association with non-syphilitic skin-diseases, viz. psoriasis and pityriasis.

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[1] Lancet, January 22, 1881.

[2] Vide infra.

ALTERATIONS IN THE CUTICLE OF THE TONGUE are likely to attract attention in an early stage, and their prompt recognition and treatment are important. Before examining the surface of a tongue, care should be taken to dry it thoroughly, since the presence of saliva masks many of the characteristic appearances.

The ordinary furred, red, or glazed tongues, which are only evidences of gastric irritation or general fever, can hardly be considered surgical, but when one side of the tongue only is covered with "fur," there must be some local cause for irritation, which will probably be found in a decayed molar tooth of the upper jaw. Hilton[1] has shown that occasionally a one-sided, furred condition of the tongue, may be symptomatic of injury to the fifth nerve in fracture of the base of the skull.

Mucous tubercles of the ordinary flat form are occasionally met with on the tongues of prostitutes, and others suffering from secondary syphilis, and in these cases confirmatory evidence will be found about the lips and inside the cheek. A *warty condition* of some of the papillæ of the dorsum of the tongue, occasionally occurs in perfectly healthy children and adults, and is best treated by paring down the growth and applying nitrate of silver.

True *papilloma* occurs occasionally upon the dorsum of the tongue, consisting in a patch of thickened mucous membrane covered with hypertrophied and prominent papillæ. In its early stage it is quite superficial, and may be readily removed with the knife, but at a later period it is apt to invade the deeper layers of the corium, and to present an appearance closely resembling epithelioma, but without any lymphatic enlargement. Possibly, in some of the successful cases of removal of portions of the tongue for epithelioma, the disease really may have been papilloma.

A loss of epithelium in patches on the dorsum of the tongue, by which a smooth, bluish surface is left, undergoing no alteration for many weeks together, is generally due to syphilis, and may be combined with a fissured and scarred condition of the sides and tip of the organ. There is a form of smooth tongue which is apt to end in cancer, but here the loss of epithelium is more uniform and extensive, and there is submucous induration. This latter form has been specially investigated by Mr. Butlin,[2] who regards the disease as a chronic inflammation of the mucous membrane, and not the result of cicatrization, but probably allied to psoriasis and ichthyosis; this view, however, is contested by Mr. Jonathan Hutchinson.

A more formidable condition is that known as *ichthyosis linguæ*, in which not only is the epithelium hypertrophied, but the papillæ are greatly enlarged, the surface of the tongue being rough, hard, and fissured. This is a chronic affection, lasting for many years, but tending eventually to develop into epithelioma. Mr. Hulke,[3] who originally described the disease, says: "Ichthyosis is characterized by tough, white, raised patches on the surface of the tongue. Their color is not unlike that of a thin film of boiled white of egg, or wet kid leather. They are clinically distinguishable from syphilitic condylomata by their thick epithelium and their wide superficial extent; and from syphilitic nodes and cancerous tumors by their restriction to the mucosa, by their exact circumscription, by the natural softness of the underlying muscular tissue (showing the absence of infiltration), and by the absence of ulceration and of infection of the lymphatics."

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[1] Lectures on Rest and Pain.

[2] Medico-Chirurgical Transactions, vol. lxi.

[3] Transactions of the Clinical Society, vol. ii.

The prominent patches may be reduced by paring or by excision, but the disease tends to run so surely, though slowly, into epithelioma, that early and complete removal of the affected portion of the tongue should be urged upon the patient before positive evidence of cancer is developed.

ULCERATION OF THE TONGUE may be simple, syphilitic, tubercular, or cancerous.

The SIMPLE ULCER is often caused by the irritation of a sharp tooth or the end of a cigar; or it may be due to dyspepsia. It is small and superficial, and, unless due to local irritation, is generally multiple, and is often found beneath the tongue. It is painful, and interferes with the movements of the tongue, but yields readily to treatment. The removal of the sharp corner of a decayed tooth with a file, or the employment of an amber mouth-piece, and the subsequent application of a stick of nitrate of silver to the ulcer, are generally sufficient to effect a cure, when the cause is local. When it is constitutional, a brisk purge with the local use of the glycerine of tannin, or any astringent gargle, will be sufficient treatment.

SYPHILITIC ULCERATION may appear during the secondary stage of the disorder along the edges of the tongue, and will almost always be found to have a corresponding white patch on the mucous membrane of the cheek. These ulcers have no induration at their bases, but when healed leave an irregular fissured border, which is very characteristic. A later form of ulceration is found in fissures of the dorsum, which leave irregular furrows in healing.

The deep syphilitic ulcer is due to the breaking down of a gumma, and it is this kind which is apt to be confounded with cancerous ulceration. The ulcer is irregular, with everted edges, and presents a yellowish slough at its base, in which a varying amount of induration can be detected. It is often in the central portion of the tongue, whereas epithelioma is more commonly at the sides; and careful investigation will show that a lump has been noticed in the organ before the ulceration commenced, and that the induration diminishes as the ulcer grows; whereas in cancer the induration follows the ulcer, and steadily increases in extent. Still, it must be admitted that cases occur in which it is impossible to give an accurate diagnosis without having recourse to the tentative administration of iodide of potassium, and that even then it is not always possible to be sure that epithelioma has not begun in an old tertiary lesion. Recourse may be had with advantage to the microscopic examination of scrapings from a doubtful ulcer, when epithelial elements characteristic of epithelioma may possibly be obtained.[1]

In the treatment of syphilitic ulceration of the tongue, regard must be had to the stage of syphilis in which it occurs, and to the previous treatment undergone. In the superficial form of ulceration, mercury, in the shape of the bichloride or the iodide, is much more effectual than the alkaline iodides alone, and should be had recourse to, unless the patient's health has been shaken by previous courses of the drug. In the tertiary form of ulcerated gumma, iodide of potassium will certainly effect a rapid cure if the ulceration is recent, provided it be given in sufficient doses, beginning with not less than 10 grains, thrice daily, and being increased to 30-grain doses, if smaller ones are not effectual. In all forms of syphilitic ulceration the local application of mercury is useful, but it must be applied, not in the form of gargles, which are used and spat out at once, but as a lotion, to be held in the mouth for five minutes, so as to "pickle" the tongue. A lotion containing the bichloride of mercury, gr. ss to f℥j of water, with a little glycerine or honey, is a very good preparation, and its strength may be increased after a time with advantage. Care must, of course, be taken that none of the fluid be swallowed.

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[1] See a paper, with drawings, by Mr. H. T. Butlin. British Medical Journal, Feb. 18, 1882.

Tubercular ulceration occurs, for the most part, at the tip of the tongue. At first superficial, and often multiple, the ulcer is apt to spread into the organ, leading to a splitting of the tip, which becomes bifid as the ulceration proceeds. This form occurs in patients who are distinctly tubercular, or on the border-land of tuberculosis; and the tongue improves if the general health can be reëstablished, or becomes more deeply excavated *pari passu* with the progress of the disease of the lungs or other organs. Locally, I have found benefit from the use of weak lotions of chromic acid, and have fancied that capping the lower incisor teeth with gutta-percha, so as to obviate the constant friction of the ulcer, has done good. Mercurial and all anti-syphilitic remedies are extremely harmful to cases of tubercular ulceration.

Cancerous ulceration is always of the epitheliomatous type. Attacking the side of the tongue, in patients usually over forty years of age, the onset of the disease is so insidious as to attract little attention, the ulcer being often attributed (and perhaps correctly as to origin) to the irritation of a tooth. When well developed, the ulcer is usually oval in shape, with sharply cut edges, and a marked induration beneath it when the parts are grasped by the finger and thumb. The pain of cancerous ulceration is a well-marked and early symptom, being lancinating and acute, and shooting up into the ear. The irritation causes a great flow of saliva, and the tongue is moved with difficulty, at first because of the pain produced, and afterwards because it is bound down by the infiltration of all the structures. The submaxillary lymphatic glands become involved early in the disease, being at first swollen and tender, and subsequently apt to suppurate and break down, causing large openings beneath the jaw. Should the disease spread towards the base of the tongue, death may occasionally follow hemorrhage from one of the lingual arteries, but in cases where the anterior part of the tongue is involved, this not unfrequently becomes adherent to the incisor portion of the lower jaw, and the disease ultimately infiltrates that bone. In these cases, the patient has generally a longer life, but one of great misery, and dies at length exhausted by pain and discharge, from numerous open sores about the chin and angles of the jaw.

In the *treatment* of epithelioma of the tongue, all surgeons of experience are agreed as to the inutility of medication, whether topical or general, and the advisability of early and complete removal of the disease. A recent discussion at the *Société de Chirurgie*,[1] of Paris, has shown that all the leading surgeons of that city are agreed with those of other countries, that the administration of iodide of potassium in true epithelioma is useless, and that the constant application of nitrate of silver is harmful. The difficulty in practice is to induce a patient to take a sufficiently grave view of his case at an early stage, when an operation may be undertaken with advantage, and with a fair prospect of relief, prolonged if not permanent. In the later stages, when the lymphatic glands are involved, it becomes a question whether any interference is advisable, and many surgeons would refuse an operation; but it appears to me that in many, even of the worst cases, temporary relief may often be given by operating, provided that the patient is prepared to run the immediate risk of the proceeding, which is undoubtedly great; and Mr. Stokes, of Dublin, has recently brought before the Clinical Society of London, cases in which he had removed the enlarged and infiltrated lymphatic glands with good results. Really, life prolonged in misery is worse than death following close upon the operation, and I have been thanked more than once by dying patients for having given relief during the few days for which they survived. Anæsthetics, moreover, have robbed operations of so much of their horror, that patients may nowadays be induced to submit to extensive mutilations which would have been impossible, or at least unadvisable, without chloroform. Chloroform is necessarily the anæsthetic to be employed in operations upon the tongue, for ether is inadmissible, first because of the difficulty of keeping the patient under its influence when atmospheric air necessarily gains free admission; and secondly because if, as often happens, a cautery is required in the course of the operation, a dangerous explosion and conflagration in the patient's mouth, may be caused by the inflammable vapor of the ether.

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[1] Medical Times and Gazette, January 8, 1881.

Ligature of the lingual artery has been advocated by both Demarquay and Moore,[1] in order to check the growth of cancer of the tongue, as well as for the arrest of hemorrhage, but has not yielded the results anticipated. I have on two occasions tied the lingual artery, once for hemorrhage occurring in the course of a case of cancer, and once with the view of checking the growth which was rapidly extending, but in neither case did the ligature appear to have any influence in staying the course of the disease.

Division of the lingual nerve is another palliative operation, recommended by Hilton and Moore, and this certainly is efficacious, for a time at least, in relieving the pain of a cancer involving the side and tip of the tongue. The operation is not a difficult one, and has the negative advantage of doing no harm if it effects little good. The operator feels for the mylo-hyoid ridge of the lower jaw, immediately below the last molar tooth, and a sharp-pointed curved bistoury, pushed through the mucous membrane at this point, will readily divide the nerve against the lower edge of the ridge, with little or no bleeding. The side of the tongue will be thoroughly numbed for some days, and then sensation slowly returns from union of the divided nerve, when the operation may be repeated.

Removal of portions of the tongue with the knife is an operation which has fallen into disuse, owing to the hemorrhage ordinarily accompanying it. Sir William Fergusson, who advocated the practice, and who thus removed more than one-half of the tongue in the case of the late Dr. John Reid, maintained that the fear of hemorrhage in these cases was exaggerated, and in his account of that particular operation, says:[2] "The bleeding for a minute or two looked formidable; several vessels were speedily secured, and there was no further trouble in this respect." It must be noted that the operation was performed without an anæsthetic, the patient being a man of great moral courage and physical endurance, and that only one lingual artery was divided. With an unconscious patient in whom both arteries have been divided far back, I have seen the very greatest difficulty arise in securing the vessels, which play across one another, and obscure the operator's view in the dark cavity of the throat.

In such cases, and in cases of secondary hemorrhage after removal of large portions of the tongue, I have found that it is practicable to arrest all bleeding in the following way. The fore-finger, passed well down to the epiglottis, is made to hook forward the hyoid bone, and drag it up as far as practicable towards the symphysis menti. The effect of this is to stretch the lingual arteries so as to completely control for the time the flow of blood through them, and in this way portions of the anterior part of the tongue may be cut off almost bloodlessly. Mr. Walter Whitehead, of Manchester, has adopted the use of scissors only, for the removal of the tongue, drawing the organ well forward, and dividing the tissues beneath by a series of snips on alternate sides, each lingual artery being secured as soon as divided.

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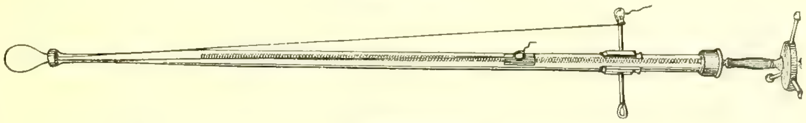
[1] Medico-Chirurgical Transactions, vol. xlv.

[2] System of Practical Surgery, p. 517.

The *ligature*, formerly used for strangulating portions of the tongue, has fallen into disuse because of the practical difficulty of keeping it sufficiently tight to insure continuous strangulation of the part to be removed, and also because of the suffering caused by the presence of a sloughing mass of tissue in the mouth. It is unnecessary therefore to consider the various modes devised for applying the ligature in former years.

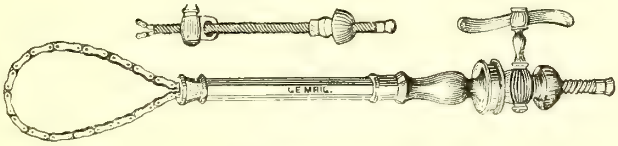
The *écraseur* has been extensively employed for removal of portions, or the whole, of the tongue, with very satisfactory results. The wire *écraseur* (Fig. 1009) answers the purpose better than the chain instrument (Fig. 1010) at first employed, in which portions of the tongue were apt to be twisted up. In order to effectually remove a diseased portion of the tongue with the *écraseur*, it is necessary to isolate the growth by passing well beyond it curved needles set in handles, around which the wire of the *écraseur* may be passed and be thus kept in its proper position. Without this precaution, the wire as it is tightened is certain to encroach upon the disease, and lead to an incomplete operation, and no forceps are sufficient alone to obviate the occurrence.

Fig. 1009.



Wire *écraseur*.

Fig. 1010.



Chain *écraseur*.

The *galvanic écraseur*,[1] used in the same way, has the advantage of cutting more readily through the tissues, which it sears at the same time, thus preventing all hemorrhage at the moment. It has however the drawback that the separation of the slough necessarily formed by the cautery, is very apt to lead to secondary hemorrhage some days after the operation, and hence the use of this instrument has been abandoned by many surgeons who formerly employed it.

Paquelin's thermo-cautère[2] is a very convenient instrument for removing small portions of the tongue, since it is not necessary in using it to pass pins beyond the growth. It is liable however to the same drawback as the galvanic cautery, viz., secondary hemorrhage.

Removal of one-half of the tongue is an operation yielding satisfactory results, and comparatively easy of performance. It was recommended by Dr. Buchanan, of Glasgow, who however divided the symphysis menti, a complication which is unnecessary in the majority of cases, as shown by Mr. Morrant Baker.[1] A thread being passed through each side of the tip of the tongue, and the mouth gagged, the operator divides the frænum linguæ and subjacent muscles with curved scissors, which he runs along the floor of the mouth on the diseased side, so as to divide the mucous membrane near the jaw, as far back as the disease reaches. Taking one thread in his left hand, and the other being held by an assistant, the operator then with a blunt-pointed straight bistoury divides the tongue strictly in the median plane, being particularly careful to divide the tough corium of the dorsal aspect well beyond the disease. Any bleeding vessel on the surface of the section is easily seen and secured, and with the fore-finger the operator then tears through any remaining muscular structure of the tongue or sublingual tissues, so as to isolate the half of the tongue to be removed. The wire loop of the *écraseur* can then be easily slipped over the apex of the tongue to the base, through which, if necessary, needles may be inserted, and the diseased half of the organ removed as far back as may be desired. Should the disease be so extensive as to require removal down to the hyoid bone, it may be necessary to resort to the plan suggested by the late Mr. Collis, of Dublin, viz. to lay open the cheek by a horizontal incision carried from the angle of the mouth. This would of course bring the parts more thoroughly into view, but with the drawback of increased hemorrhage and permanent deformity. By employing an *écraseur* with the end slightly curved, I have been able, in several cases in which I have removed half the tongue, to dispense with any external incision.

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[1] See Vol. I. page 524, Fig. 94.

[2] See Vol. I. page 504, Fig. 77.

Removal of the whole breadth of the tongue may be readily performed with the *écraseur* when the disease involves only the anterior portion of the organ, but when it extends further back, free division of the sublingual tissues, as recommended by Sir James Paget, will be necessary, in order to allow of the satisfactory application of the wire-loop to the base of the organ. Mr. Baker has recommended that, in cases requiring removal, the tongue should be split, and the halves removed by two *écraseurs* simultaneously, and both methods are for all practical purposes identical. Nunneley's method of applying the *écraseur* for removal of the entire tongue is as follows: An incision is made in the median line, between the chin and the hyoid bone, and is carried up between the genio-hyo-glossi muscles into the mouth, the chain of an *écraseur* being then carried through this. The base of the tongue being next transfixed from above downwards by three pins, the chain is passed behind them, and the *écraseur* is worked from beneath the chin. The objection to this method is that the tongue is necessarily cut obliquely, notwithstanding the use of the pins. Its advantage is that a useful drain for discharges is maintained from the floor of the mouth. Mr. Barwell has modified Nunneley's[2] method by making a small supra-hyoid wound, and carrying a thread into the mouth by means of a handled needle much farther back than in the older method. The needle is made to enter the mouth close to the last molar tooth on each side, and the wire of the *écraseur* is drawn by the thread through the supra-hyoid wound and around the base of the tongue. A handled needle is then passed from before backwards through the tongue at the point where the section is to be made, and the wire slipped behind it. When the tongue has been thus divided transversely, a second *écraseur* is applied in the mouth to divide the sublingual tissues which have been left. Mr. Barwell claims for this method that it leaves a painless stump, because the lingual-gustatory nerves are divided close to the lower jaw; but this result is not peculiar to this particular operation, which does not appear to possess any special advantages over that in which the sublingual tissues are divided before the section of the tongue, whilst if hemorrhage should occur on completion of the section of the tongue, that organ would be very much in the way of the application of a ligature.

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[1] Lancet, vol. i. 1880.

[2] Lancet, April 19, 1879.

Mr. Barwell has introduced into practice a form of wire for the *écraseur* which promises to be very serviceable. It consists of a strand of Newall's patent wire rope, made of untempered steel, with a thread in its centre, and is more flexible than any steel wire.

Regnoli, in 1838, devised a *submental operation* which consists in dividing the floor of the mouth close to the lower jaw, from one facial artery to the other, so as to allow of the tongue being drawn down and fully exposed. It may then be removed with the knife or *écraseur*; but if the knife be employed, care should be taken to divide only one lingual artery at a time. I have assisted in the performance of this operation more than once, and think that for slight cases it is an unnecessarily severe proceeding, and has no advantage over the intra-buccal method; while for the more serious cases in which it is necessary to go close to the hyoid bone, it has the drawback that the surgeon is working in a hole where it is very difficult to see and secure a bleeding artery.

Sédillot and Syme were the first to *divide the lower jaw* in order more thoroughly to extirpate the tongue. The operation is a very severe one, but affords the only satisfactory method of dealing with cases of extensive disease of the tongue, in which the floor of the mouth is involved. An incision in the median line of the lower lip, prolonged to the hyoid bone, will allow of the dissection of the lip from the lower jaw for about a quarter of an inch on each side. With a drill the bone can then be perforated on each side of the median line, and about midway in the depth of the jaw, so as to admit of the two halves being subsequently drawn together with wire. The jaw is next to be divided exactly in the median line with a fine saw, which may advantageously have its handle raised above the level of the blade, so as to be out of the way of the patient's chest. The advantage of dividing the bone in the median line is that the teeth are not interfered with, whereas in Sédillot's method of dividing the jaw by a **>** cut, it is necessary to sacrifice all the incisor teeth. In addition to the wire employed to bind the halves of the jaw together, the action of the muscles tends to maintain the parts in relation and to press the halves of the jaw together, rendering the notching of the bone an unnecessary complication. If the section be completed with the bone-forceps when about half the thickness of the bone has been divided with the saw, the slight irregularity thus produced assists also in maintaining the parts in apposition. The halves of the jaw being held asunder with hooks, the operator cuts the genio-hyo-glossi muscles from the jaw with a pair of scissors, leaving the attachments of the genio-hyoid muscles. With the forefinger and scissors, the tongue can then be dissected up from the floor of the mouth, with the sublingual glands and mucous membrane, until the hyoid bone is reached, firm traction being made with a stout string passed through the tip. The tongue being then drawn down, the palato-glossi muscles forming the anterior pillars of the fauces will be put on the stretch, and must be divided with scissors, after which a handled needle should be passed through the tongue close to the hyoid bone, and the wire of the *écraseur* then adjusted.

The surgeon should be prepared with a handled needle and stout thread, to transfix and hold the small remnant of tissue left attached to the hyoid bone, should the breathing be embarrassed by the epiglottis and base of the tongue falling backward. In my experience this is much more likely to happen when a considerable portion of the tongue is left, than when the section is made far back, and the difficulty seems to arise from the weight of the piece left, forcing back the epiglottis when the sublingual muscles have been divided.

All hemorrhage having been checked, the two halves of the jaw are to be brought together with a piece of stout silver wire. This may be passed from before backwards readily enough through the hole in one side of the jaw, but it is not easy to pass it back again on the opposite side, unless a loop of thin wire be passed from before backwards through the hole already made, into which the end of the wire can be bent, and thus drawn forward. The two halves of the jaw should be brought into close and correct apposition, and the ends of the wire twisted and brought up beneath the lip. The lip is then to be brought together with hare-lip pins, and a fine silk stitch in the mucous membrane, but care should be taken to leave the lower part of the incision open, so that there may be a free drain for the saliva and discharges from the mouth. In removing the wire from the jaw, at the end of three weeks or more, it will be found convenient to cut the wire close to the jaw on each side, and then with a blunt hook to pull out the loop from behind. When the disease involves the anterior part of the tongue, it is by no means uncommon to find the tongue adherent to the incisive portion of the jaw, and the bone more or less infiltrated, as shown by the loosening of the teeth and softening of the bone. Under these circumstances, it is necessary after clearing the bone to apply the saw on each side of the diseased portion, as far from the median line as may be necessary to reach healthy bone. After removal of the portion of bone with the diseased tongue, it is quite useless to attempt to wire the remaining portions of the jaw together, since it is impracticable to draw them in apposition at the time. And yet it will be found, in a few weeks, that as the wound heals the two sides of the jaw are gradually approximated by the action of the muscles, and will eventually in many cases unite firmly.[1]

In all operations for removal of the tongue, it is well to be prepared for unexpected hemorrhage, which may be very urgent. Blood collecting in the pharynx may embarrass the breathing very much, and, by the congestion produced, keep up venous bleeding. Under these circumstances it is well to perform laryngotomy at once, and if blood has entered the lungs, as is very apt to happen when the tongue is dragged forward, to suck out the blood through the tube. I have twice seen patients rescued from imminent danger of suffocation in this way, and ultimately make good recoveries.

With the view of obviating all risk of suffocation during the operation, and also to facilitate the administration of the anæsthetic, recourse may be had, before commencing the operation of removal of the tongue, to laryngotomy or tracheotomy, and the use of *Trendelenburg's tampon.* This consists of an India-rubber tube, which covers the tracheal canula, and which can be inflated so as to plug the trachea and prevent the admission of blood; but an equally satisfactory method is to plug the pharynx with a sponge to which a string has been attached. A flexible tube attached to the ordinary tracheal canula allows of the ready administration of chloroform vapor. I have employed this method on one occasion, and have seen it employed on others, but it appears in most cases to be an unnecessary complication.

The *after-treatment* of cases of removal of the half or entire tongue, consists in maintaining the strength of the patient by judicious feeding, and in keeping the mouth sweet. Feeding is best accomplished with the ordinary earthenware feeder, having a spout to which an India-rubber tube may be fitted, if it is necessary to carry the food very far back. In this way, sufficient milk, beef-tea, and brandy may be administered until the patient prefers to take nourishment from a cup, which he often does earlier than might be expected. Should the feeding by the mouth be insufficient, recourse should be had to nutrient enemata.

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[1] For cases, see Lancet, vol. i. 1876.

With regard to cleanliness and prevention of fetor, it is very desirable that at the time of the operation all divided tissues should be thoroughly mopped with a forty-grain solution of chloride of zinc, or be freely powdered with Iodoform, either of which applications not only obviates fetor, but tends powerfully to prevent the absorption of septic matter. The frequent washing out of the mouth with a lotion of permanganate of potassium or lime (the latter by preference), is most readily accomplished with a siphon douche fitted with a soft-rubber nipple, which the patient can direct himself without risk of hurting the mouth. After each washing, the mouth should be brushed out with the glycerine of carbolic acid or "terebene," either of which answers admirably in preventing fetor.

It has been suggested that the lobular pneumonia which occasionally proves fatal in some cases of removal of the tongue, is due to septic influence consequent upon the state of the mouth. The cases which end fatally occur however among elderly patients, who have become greatly reduced by the disease, and who would be likely under any circumstances to suffer from lung complications of a low type. With the view of obviating this supposed septic influence, my colleague Mr. Arthur Barker[1] has in a few cases allowed the patient to wear a tracheotomy tube for some days, and to breathe only through it, the mouth and nostrils being carefully covered with cotton-wool, and a drain for saliva being established through the floor of the mouth.

In cases of *recurrence* after removal of the tongue for epithelioma, the disease shows itself in the stump or in the submaxillary lymphatic gland, or more frequently I think in both, though I have known both to escape, and the disease to re-appear in the lymphatic gland beneath the sterno-mastoid, first on one side and then on the other. The infiltration of the glands always spreads to those beneath the sterno-mastoid, should the patient survive sufficiently long, but death usually surpervenes after a few months from general asthenia and exhaustion, the sufferer being worn out by pain and, should the submaxillary lymphatic glands suppurate and open externally, as they frequently do, by the constant discharge. In cases where recovery is permanent, and the patient remains well for years, one is almost tempted to suspect a mistaken diagnosis; and it must be acknowledged that mistakes have been made by good surgeons in removing tongues, the subject of gumma, for examples of epithelioma. I am able, however, to record the survival for over twelve years of a patient from whom I removed what was believed to be a tongue affected by medullary cancer. The patient was sixty years of age, and the disease had existed six months. On looking into the mouth, there was between the tongue and the lower jaw on the left side, a ragged, ulcerated surface, occupying the floor of the mouth. This was prolonged to the side of the tongue, and with the finger a large mass could be felt in the substance of the organ, extending beyond the median line, and to about two inches from the tip. The patient complained of constant pain in the tongue, but was otherwise in good health. There was a slight enlargement of one of the submaxillary lymphatic glands. After section of the lower jaw in the median line, I removed, with the *écraseur*, the anterior half of the tongue, in September, 1868. The patient made a good but slow recovery, and called on me in 1880, nearly twelve years after the operation, perfectly well. The part removed was exhibited to the Pathological Society of London, and was submitted to the Committee on Morbid Growths. To the naked eye the tumor presented the

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[1] Lancet, August, 1879.

appearance of medullary cancer, and was reported by the committee to consist of cells and nuclei. The conclusion drawn was as follows: "The opinion we formed is that the tumor was essentially a cell-growth invading and displacing the normal tissues, the cell-growth forming equally the more obvious cell-structure of the tumor and its fibrous portion. We may add that it seemed to us most probable that the larger forms of cells were developed out of the smaller forms, and that therefore the spongy portion of the tumor in which the larger cells were most abundant represented a later phase of development than the homogeneous portion."[1] In this case I noticed particularly a point which is not often seen, viz., the extent to which the portion of tongue left behind grows or becomes stretched. In the case in question, notwithstanding the extensive removal, the man some years after appeared to have a tongue of ordinary size, but rather more sessile in the mouth than normal.

When recurrence of cancer takes place, the case is generally beyond surgical aid, the disease usually infiltrating the tissues of the mouth and of the neck to an extent which forbids any interference. It seems to me, however, that occasionally an attempt should be made to rescue the sufferer from an early and miserable death, as in the following instance:—

A man, aged sixty-two, was sent to me in 1875, with very extensive cancerous disease of the tongue and sublingual tissues. In January, 1874, he noticed a swelling of one of the submaxillary glands, and soon after a sore beneath the tongue. The sore healed, and the gland subsided under treatment. In September, 1874, the gland began again to swell, and at last broke. At the same time he found that he had difficulty in articulating, as the tongue was fixed to the floor of the mouth, and eventually the tip of the tongue became fixed to the jaw. The latter condition was temporarily relieved by an operation at another hospital. On admission to University College Hospital, the patient was unable to protrude his tongue or move it in his mouth, the saliva constantly trickled away, and articulation was very imperfect. He complained of great pain in the occipital region, but of none in the tongue. The gums of the incisor region were swollen and ulcerated, and the teeth loose. The tongue was fixed to the back of the incisive portion of the jaw, which was softened. All the tissues beneath the tongue were indurated, but the skin was not involved.

On September 29, I removed the tongue, centre of the jaw, and all the sublingual tissues, by dividing the chin in the middle line, then sawing the jaw through on each side, and, having isolated the tongue somewhat on each side, inclosing the whole of the disease with the wire of the galvanic *écraseur.* The parts removed consisted of the middle three inches of the lower jaw, nearly the whole of the tongue, and the sublingual muscles and glands *en masse.* At the posterior end, the mass measured two and a half inches in depth, and slightly more from side to side. The tongue appeared to be healthy except at the anterior part; and on the left side, just behind the tip, was a nodule of the size of a pea. Beneath the tongue was a mass of yellowish-white, firm tissue, with a granular surface, which was continued quite up to the cut margin. This tissue, on microscopical examination, proved to be epithelioma.

The patient made a good recovery, and was alive and well six years after the operation. He recovered a surprising amount of power of deglutition, and of speech, due principally to the growth of the stump of the tongue already noticed. The occipital pain complained of by this patient is difficult of explanation, but it was entirely relieved by the operation. I have noticed it in other cases of cancer of the tongue.[2]

My friend and former pupil, Mr. Rushton Parker, of Liverpool, has recorded[3] two cases in which he performed almost as extensive operations as in the foregoing case. In one patient, aged fifty-eight, he removed, in 1876, half the tongue, parts of the upper and lower jaws, the submaxillary glands, and a portion of the pharynx, for extensive epithelioma, the patient recovering, and being perfectly well in 1880. In the other patient, aged fifty-four, he removed one-half of the tongue, half the soft palate, the side of the pharynx, the submaxillary glands, and part of the lower jaw, for epithelioma, but unfortunately a recurrence of the disease took place in the neck.

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[1] Pathological Society's Transactions, vol. xx.

[2] Lancet, vol. i. 1876.

[3] Medical Times and Gazette, December 1, 1877.

Malformations and Diseases of the Palate.

Cleft Palate.—Cleft palate occurs in infants otherwise well formed, or in combination with harelip, and in either case may affect the soft palate only, or both the hard and the soft palates. When harelip is present, the fissure usually extends from the lip through the alveolus and the entire palate; but there are many exceptions, a fissure of the soft palate alone frequently accompanying a single harelip. That both affections are the result of arrest of development in the early weeks of fœtal life, cannot be doubted, and that they are hereditary cannot be denied. Still, cases of cleft palate occur in families not known to inherit the malformation, and in the great majority of cases it will be found that the mother has been much out of health in the early weeks of pregnancy, or that the pregnancy has followed very closely upon a previous one, or has occurred during lactation.

The experience of Professor Haughton, of Dublin, first showed, in the case of the larger carnivora, the effect of diet upon the production of cleft palate; and it is very desirable in the case of a parent the subject of the deformity herself, or having already given birth to a child with cleft palate, that in subsequent pregnancies every care should be taken to improve her health, and to administer food and medicines calculated to promote the formation of bone.

When a harelip and cleft palate are continuous, the latter deformity is sufficiently obvious; but when a cleft palate occurs alone, it may be easily overlooked for the first few hours of life, and the earliest intimation of the malformation may be given by the inability of the infant to suck, and by the fact that milk introduced into its mouth with a spoon returns through the nostrils. Under these circumstances, infants are often allowed to pine away through insufficient feeding, but with proper care this may generally be obviated.

A large-sized, India-rubber teat, or an ordinary covered spoon, such as is used for the administration of nauseous medicines, may be used to convey the milk to the gullet; but a much less troublesome and more effectual method is that adopted by Mr. Oakley Coles,[1] who attaches a flap of elastic India-rubber to the nipple of an ordinary feeding-bottle. This overlies the nipple, and is introduced into the mouth with it, and, when the infant is suckled, rises up against the cleft and enables the child to swallow. The India-rubber is undoubtedly the cleanest and most effectual flap which can be employed, but I have often directed the use of a leaf-shaped piece of kid leather with advantage, when the India-rubber could not be readily procured. Mr. Francis Mason[2] has employed a very thin plate of soft metal, moulded to the patient's mouth, but acknowledges that the instrument is not available in all cases. If no other plan is adopted, the mere closing of the nostrils by the nurse's finger and thumb, at each effort of deglutition, will give material assistance to successful swallowing.

The question of surgical interference in cases of cleft palate is one which must be considered as still *sub judice*. That it is possible to close the entire length of a cleft, extending through both hard and soft palates, at an early age, is undoubted; but it may be questioned whether in many of these cases a better result, as regards articulation, would not have been obtained by the use of some form of apparatus. It is most satisfactory to the parents of a child suffering from any congenital malformation, that the deformity should be repaired by operation as soon as possible, but grave disappointment is apt to follow when, as years go on, the power of articulation fails to improve in the ratio anticipated. The sufferer is inclined to complain that the operation has not improved his voice as much as his power of eating comfortably, and is sometimes annoyed to find that no mechanical contrivance can be subsequently worn, without undoing what was effected with so much trouble and suffering some years before.

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[1] Deformities of the Mouth, Congenital and Acquired, with their Mechanical Treatment. London, 1881.

[2] On Harelip and Cleft Palate. London, 1877.

In deciding, therefore, as to the propriety of an operation for cleft palate, it is necessary to take into account not merely the mechanical difficulty of bringing the soft tissues on each side of the median line into sufficiently close proximity to unite, but also the *length* of the palate, and the probability that it will sufficiently shut off the mouth from the nose to prevent the nasal intonation which is commonly met with, both before and after these operations. In no case of successful operation for cleft palate, I believe, is the palate sufficiently in contact with the back of the pharynx to allow water to be injected from one nostril into the other without entering the pharynx when the mouth is open, as is the case in well-formed throats. And yet many of these patients have very little nasal intonation, which is to be explained, I believe, by the hypertrophied condition of the muscles forming the pillars of the fauces, which may be seen when the patient attempts to swallow with the mouth open, acting powerfully to narrow the fauces, and thus make up for the deficient length of the palate.

Before deciding therefore as to the advisability of an operation upon the soft palate, it is well to grasp the chin of the patient and hold the mouth open so as to aid his efforts at swallowing, when if the two halves of the soft palate come in contact in nearly their whole length, while the superior constrictor and palato-pharyngeal muscles closely approximate the palate and pharynx, the case is one in which union may almost certainly be obtained, and probably a fair result as regards phonation.

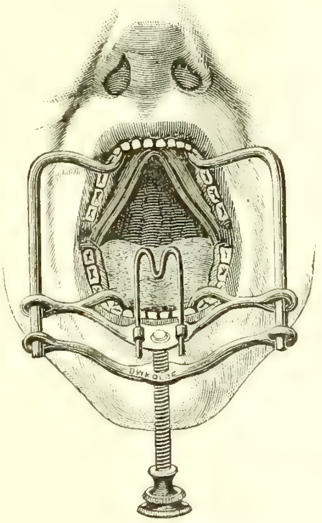
In the case of the hard palate, there is an undoubted disposition for the two sides of the cleft to approach one another for some years after birth; and this is particularly seen in cases complicated with harelip, in which the successful closing of the lip tends powerfully to approximate the divided edges of the alveolus and palate. But success in closing the fissure in a hard palate depends in no small degree upon the mode in which the palate is arched. As was pointed out by Sir W. Fergusson, in cases of highly arched palates, which in section would resemble a Gothic arch, it is comparatively easy to dissect down the muco-periosteum sufficiently to make the flaps approximate; while in palates but slightly arched, and the section of which could resemble a Norman arch, it is difficult to get the flaps together, and the tension must necessarily be severe.

It is quite true that these cases of slightly arched palate give the best results as regards the voice, when the operation is successful, and that the high palates, when most successfully closed, are apt to lead to disappointment; but this might well be anticipated, since it is by no means uncommon for a person with a healthy, high palate, to speak with a nasal intonation closely resembling that of one suffering from a congenital cleft, or from perforation by disease.

The effort involuntarily made by all patients, the subjects of cleft palate, to shut off the nose from the mouth in speaking, is aided as they grow up by a voluntary closure of the nostrils which is very remarkable. Ordinarily, in man, the nostrils are perfectly quiet in tranquil respiration, and it requires considerable effort to close them, as when plunging the face into water. A patient with cleft palate, on the contrary, may be noticed to put his *compressores narium* into strong action every time he speaks or swallows, and it is very difficult to overcome the habit when the necessity for it has passed away, through either a successful operation or the adaptation of well-fitting apparatus.

Staphyloraphy, or the operation for closure of a cleft palate, was up to the last fifteen years almost invariably postponed until the period of puberty, or later, so that the surgeon might have the patient's self-control to aid him in his troublesome and tedious operation. A few cases had no doubt been operated upon in childhood, with indifferent success, by Mason Warren and others, but to Mr. Thomas Smith, of St. Bartholomew's and the Children's Hospital, is mainly due the credit of showing that it is possible to operate in infancy under chloroform, not only without risk but with very great success. In his paper in the Medico-Chirurgical Transactions (1868), Mr. Smith described a gag by which the mouth of the patient can be kept sufficiently open, and which, in some form or other, is essential for the due performance of the operation, now performed by him as follows. [Fig. 1011 illustrates a convenient form of mouth-gag and tongue-depressor combined.]

Fig. 1011.

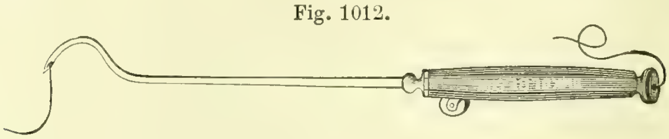


Mears's mouth-gag for staphyloraphy.

The patient is placed on a table of convenient height, facing the window, and if possible a northern light. The head is supported by an air-cushion, and is firmly held by an assistant standing behind, while the arms and legs are strapped down to prevent struggling. The operator stands on the right of the patient and the chloroformist on his left. The patient being thoroughly narcotized, the gag is introduced and the mouth screwed open, the rings of the gag being held by the thumbs of the assistant supporting the patient's head. The edges of the cleft are then pared with a slender, double-edged knife, which is thrust through the margin of one side of the soft palate, held tense with forceps, and made to cut up, and then down to the end of the uvula. The margin thus separated is caught with the forceps, and the section completed up to the angle of the cleft, if possible as one sweep, or, if not, by a reapplication of the knife. The same process is repeated on the other side, and in favorable cases it is both possible and satisfactory to remove the parings of both sides of the palate in one piece.

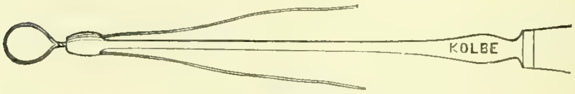
The closure of the soft palate is then proceeded with, fine silver wire being used, with horse-hair or silk for the uvula. Mr. Smith employs a sharply-curved, tubular needle, for the wire, which is carried on a wheel in the handle of the instrument (Fig. 1012), and which can be projected when the point has traversed both sides of the palate. A twister (Fig. 1013) is employed to twist the wire up, but the last few turns are more conveniently given at the conclusion of the operation with a pair of torsion-forceps. The horse-hair is softened in warm water, and is introduced with a small curved or rectangular needle set in a handle, being passed through both sides of the palate, and caught with a "catcher" or forceps. The horse-hair is simply tied with three knots so as not to slip. Should there be a fissure of the hard palate, the operator proceeds to detach the muco-periosteum by a modification of Langenbeck's urano-plastic method; making a puncture near the alveolus, he introduces a palatal raspatory of small size, and brings the point out in the fissure. Then meeting this with a strong aneurism-needle, he replaces the raspatory with the needle, withdrawing the former altogether, and working with the needle from the fissure towards the alveolus. In this way, aided, if necessary, by the leverage of strong, curved scissors, the muco-periosteum of the hard palate is sufficiently detached, the hemorrhage, if troublesome, being controlled from time to time by a small sponge pressed against the palate. With the curved scissors, the soft palate is then detached from the bone of the hard, one blade being passed beneath the muco-periosteum, and the other above the soft palate so as to divide the tissue transversely close to the horizontal plate of the palate bone. The muco-periosteal flaps of the hard palate are now closed by a sufficient number of fine wire sutures, and lastly an incision, as recommended by Dieffenbach, is made on each side of the soft palate, so as to thoroughly loosen it and take all tension off the stitches, which are then finally adjusted with torsion forceps.

Fig. 1012.



Tubular needle.

Fig. 1013.



Coghill's wire-twister.

In this operation, no formal division of the levator palati muscles, as recommended by Sir W. Fergusson, is undertaken, but it is probable that the lateral incisions in the soft palate divide to a great extent the insertions of the levators, while the detachment of the soft from the osseous hard palate must necessarily divide the insertion of the tensors of the palate.

Many operators, myself among them, have found that they have obtained good union of the soft palate without even lateral incisions; but where the tension is great these should not be omitted, and in cases of great muscular irritability of the palate, the systematic division of the levators may be undertaken with advantage. Whether the division be performed as recommended by Sir W. Fergusson, with a lancet-shaped blade set at right angles to the shaft of the knife, and introduced above the soft palate, or with a straight knife thrust through the palate as proposed by Mr. Pollock, the division should be performed after the introduction of the stitches, which both serve to render the muscles tense, and also are more readily introduced before the hemorrhage which is caused by the myotomy, and which is sometimes severe, obscures the view.

The material for, and the method of introducing, the stitches, vary in the hands of different surgeons. Sir W. Fergusson preferred purse silk, and employed the method devised by Mr. Avery for introducing it, as follows: An ordinary palate-needle, carrying the silk, was passed from before backwards through the margin of the soft palate, and the loop caught with forceps and drawn out of the fissure. This being repeated on the opposite side, one silk was looped through the other, and drawn by this means across the fissure and through both sides of the palate. In tying the silk it is convenient to use a sliding-knot, that is, one end is simply knotted firmly upon the other, when by pulling the silk the knot is slid up to the palate and will keep its place while a second knot is made over it.

In the after-treatment of a case of cleft-palate operation, it is essential that plenty of liquid nourishment should be given in the first day or two, and be followed up by semi-solid food, so that the patient's strength may be well supported, and the process of healing accelerated. The idea that any effort at swallowing, even of the saliva, must necessarily tear open the wound, was shown by Sir Wm. Fergusson to be fallacious, and the practice of starving the patient, first decried by Sir Philip Crampton, is now universally abandoned. Talking should be forbidden for the first few days, and it is undesirable that the patient should be exposed to any chance of taking cold by exposure to draught or east wind.

The time for removing the stitches after an operation for cleft palate has been greatly modified of late years, and it has come to be thought by the most experienced operators that the longer they are left the better. In most cases, silk or horse-hair sutures should be removed in from ten days to a fortnight, but fine wire sutures may be left for weeks or even months, as long as they do not scratch the tongue.

In order to improve the voice, in cases of successful staphyloraphy in which the nasal tone persists, Mr. Francis Mason[1] has proposed to divide the united soft palate on each side by a longitudinal incision, so that the soft palate may be loosened and made more flexible. The results are, however, disappointing, as the cicatrization which necessarily ensues leaves the parts much as before.

M. Passavant, with the same object in view, proposed to make a transverse incision in the soft palate, which could then be drawn forward and reversed. A portion of the mucous membrane of the upper surface was then to be dissected off, and a corresponding portion of the mucous membrane of the pharynx, and the two raw surfaces were to be brought together with a few sutures. As Sédillot remarks, however, it is difficult to understand how the two surfaces could be brought in contact; and the experience of all surgeons goes to show that permanent separation of the posterior nares and pharynx by cicatricial tissue is certain to produce nasal intonation.

Uranoplasty.—In describing the operation usually performed by Mr. T. Smith, it will be noticed that the entire fissure in both hard and soft palates is closed by the same operation. This practice is not followed by some surgeons, who content themselves with closing the soft palate first, hoping thus to influence the approximation of the two halves of the hard palate; or, in cases too wide for closure, to employ an artificial palate. It seems to me, however, that it is very undesirable to close the soft palate when the hard palate cannot be closed, for in these severe cases the soft palate is both small and short, and the results, therefore, as regards the voice, are most unsatisfactory, even after the gap in the hard palate has been filled artificially. Again, if the patient is to be subjected to the inconvenience of wearing an artificial palate at all, he may as well be fitted with one to fill up the whole cleft, and thus improve the voice, which will be impossible if the scanty soft palate has been united.

The late Dr. Mason Warren,[2] of Boston, was the pioneer in closing fissures of the hard palate by dissecting down a flap of mucous membrane, and his success was such as to encourage other surgeons to imitate his practice. He

[1] Lancet, vol. ii. 1869.

[2] American Journal of the Medical Sciences. 1848.

worked *from* the margin of the cleft, using sharp knives bent at a right angle to detach the periosteum, which was then united with sutures. Mr. Avery was the first to follow his example in England.

In 1862, Langenbeck published his experience of operating from the alveolus *towards* the margin of the cleft, and laid especial stress upon detaching the periosteum, by means of blunt raspatories, to form part of the thickness of the flap. Having performed this operation on several occasions with good success, I can speak well of it, notwithstanding that the incision near the alveolus may, if carried too far back, give rise to troublesome hemorrhage. Two instances in which nearly fatal hemorrhage occurred from the posterior palatine artery, have been recorded by Mr. Howard Marsh,[1] in both of which the bleeding was successfully arrested by plugging the palatine canal with a wooden plug, pushed through the palate.

In 1874, Sir William Fergusson brought forward what was then believed to be a new proposal, but was afterwards shown to be a revival of a suggestion of Dieffenbach's—viz., to detach the bony edge of the hard palate with a chisel, and to push the two portions of the hard palate toward the median line. In his early cases Fergusson used silk sutures, but he subsequently found that he gained sufficient approximation by stopping the gap made on each side with lint. In this proceeding, the damage done to the parts is considerable, and necrosis, with some exfoliation, is apt to follow. Mr. Mason[2] has proposed to limit the action of the chisel by boring holes in the line of incision with a bradawl, before the chisel is applied; but even with this modification the operation is one of limited application, which has not found favor with many surgeons.

Although the surgeon will not undertake to supply artificial aid himself in cases of deformity of the mouth, it is essential that he should be able to advise his patient in the matter, and possibly direct the dentist or mechanician as to the method to be adopted. In Mr. James Salter's[3] and Mr. Oakley Coles's[4] works, there will be found complete historical accounts of the methods adopted by successive practitioners to obviate mechanically the deformities of the palate; but for surgical purposes, it will be sufficient to say that as regards congenital cleft palate, it is only during the last sixty years that anything like success has been attained. In 1820, M. De la Barre seems first to have employed "elastic gum" in making artificial palates; and in 1828, Mr. Snell made a palate of gold with a movable velum, which was subsequently improved by Stearn (1845), Sercombe (1857), and Parkinson (1867). All these palates acted simply as obturators—that is, were placed below the palate and overlapped the margins of the cleft, thus more or less completely shutting off the nose from the mouth. In 1864, Dr. Norman Kingsley, of New York, brought before the Odontological Society of Great Britain an artificial palate made entirely of vulcanized rubber, cast in moulds of metal taken from impressions in plaster-of-Paris. The velum of soft rubber had the great peculiarity that it fitted between the halves of the split palate, and moved with them, at the same time filling up the gap between the palate and back of the pharynx. With this palate, adapted by Mr. Coles, I have seen very remarkable results; but the method has the drawback that, if applied to patients whose growth is not complete, frequent alterations are required, in addition to the fact that the soft rubber wears out and requires renewal. A palate on a totally different principle, contrived originally by Dr. Wilhelm Swersen, of Berlin, and lately brought to my notice by Mr. Oakley Coles, appears in many cases to afford the most satisfactory means of treating cases of wide congenital cleft of the palate. It consists entirely of hard rubber, the posterior part being much thicker than the hard palate, to which it is attached by a narrow stem; this posterior part, which is triangular in shape, is set at an angle so as to pass above the soft palate and fill up the cavity of the pharynx, the edges of the soft palate coming in contact with it in deglutition and phonation. Mr. Coles has found that the tone of the voice is improved by substituting gold in the hard palate. Having induced a highly intelligent medical student to try one of these palates, after having worn one of Kingsley's, he informs me that he has no hesitation in giving the preference to the former, whilst I am able to testify personally to the improvement of his voice.

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[1] Clinical Society's Transactions, vol. xi.

[2] Lancet, Oct. 24, 1874.

[3] Dental Pathology and Surgery. London, 1874.

[4] Deformities of the Mouth. London, 1881.

Whatever method of treating a congenital cleft palate may be adopted, the improvement in the voice must be gained, to a great degree, by education. A patient has in the first few years of life acquired vicious habits of speaking, and particularly a guttural and nasal tone, which requires great care to overcome. It is essential that he should be taught to speak with his lips, and to throw the voice forward. With proper teaching and diligent practice, he will in time speak as distinctly as the majority of healthy persons.

Ulceration of the palate is usually of syphilitic origin. Mucous patches with superficial ulceration, more or less circular in shape, are not infrequent in the secondary stage of syphilis, but the well-marked ragged ulcers, with a yellow base, are found either in tertiary or congenital syphilis. The mucous patches yield readily to ordinary anti-syphilitic treatment, but the tertiary ulcers are apt to perforate the soft palate and eat into the uvula, or may destroy the muco-periosteum of the hard palate, and lead to exfoliation of bone. The existence of so-called strumous or tubercular ulceration of the palate may be doubted, since in these cases a rapid cure is effected by the administration of the iodides in full doses, exactly as in cases of recognized, tertiary syphilis. The adhesions of the palate to the pharynx which are apt to follow extensive tertiary ulceration are best let alone, since any surgical interference is not likely to improve the intonation. When the soft palate is destroyed, or the hard perforated, an obturator may be worn with advantage.

Nodes of the hard palate are not infrequent in constitutional syphilis, and in the recent state are apt to be confounded with abscess. An abscess always extends from the alveolus, and usually that of the incisor teeth, which will be found to be painful and loosened; and on applying pressure to the swelling, pus exudes by the sides of the teeth. A node, on the other hand, is less rapid in formation than an abscess, and is isolated from the alveolus, the teeth being firm, although possibly tender. The distinction between the two affections is important, since the early incision, which is essential in the cure of the abscess, in order to prevent necrosis, will in all probability lead to this very result if the node be incised, whereas the latter will rapidly subside under the free administration of the iodides.

Necrosis of the hard palate, when it occurs, is followed by very slow exfoliation, and nothing can be done to hasten the process. The use of detergent mouth-washes to keep down the fetor, and the removal of sequestra as they form, constitute the whole treatment.

Fortunately, exposed portions of the hard palate do not always necrose, but have a singular power of recuperation, due doubtless to the abundant vascular supply to both surfaces of the palate. In order that bare bone may thus recover, it is essential, however, that it should be protected from the constant contact of the tongue, and the lodgment of particles of food. For this purpose, a metallic or vulcanite plate must be fitted to the mouth, so as to cover without pressing against the affected part. This is even more important when a small exfoliation with perforation has taken place, for even then if the parts are healthy a cure may thus be effected. Any attempt to plug such an aperture must inevitably lead to its rapid enlargement, and, if persisted in, will cause absorption of the entire palatine process, as in a specimen in the museum of St. Bartholomew's Hospital, London.

Tumors of the Palate.—A case of *papillary tumor* of the hard palate has been described by Salter, which, as it recurred, was probably an example of true papilloma.

A few cases of *congenital tumor* of the palate are recorded, one of the most recent being an example of *dermoid tumor*, springing from the upper surface of the soft palate, in a child of three years. It was removed by Mr. Morrant Baker, and was exhibited at the Pathological Society of London, in April, 1881, by Dr. Hale White, who described the tumor as two inches in length, with a wide base, and consisting of epidermis, papillæ, corium, and fat, and having on one surface a plate of cartilage. In the museum of St. Bartholomew's Hospital, is a section of a boy's head with a large lobed tumor of *myxomatous* structure in the soft palate, which suffocated the patient by obstructing the larynx.

The *glandular* structure of the soft palate, which in health forms a considerable portion of its thickness, may become hypertrophied and form a tumor; and this, from its position, may give rise to great inconvenience by interfering with the voice and deglutition. A case of the kind was under my notice for some months, in the person of a married lady aged thirty-four, otherwise in good health. As the tumor slowly increased and interfered with her profession as a vocalist, I thought it right to interfere, and in July, 1879, having taken the precaution to perform tracheotomy, and to introduce Trendelenburg's tampon to obviate the entry of blood into the windpipe, I incised the tumor, and was agreeably surprised to find that I was able to turn out with the finger, from between the layers of the palate, a soft mass of gland structure, distinctly encapsuled, afterwards withdrawing the containing cyst. The patient made a good recovery, and has remained well since. *Encysted tumors*, probably of the same nature, have been met with in the hard palate.

Sarcoma of the round-celled variety affects both the hard and soft palate. I had recently under my care a child of seven, with a tumor of the right side of the soft palate, which had been punctured under the idea that it was an abscess. It closely resembled the tumor in the preceding case, externally, but upon cutting into it I found it extensively attached, and a small portion removed for examination proved it to be a round-celled sarcoma. The child survived six months. In a woman aged forty-eight, who had a tumor of the hard palate, the size of a horse-chestnut, which had been noticed from childhood but had latterly increased rapidly, I succeeded in removing the growth, which proved to be a round-celled sarcoma, and, by the application of the actual cautery to the bone from which it sprang, induced a superficial exfoliation with, I believe, a permanent cure.[1] A similar specimen, removed by Sir Wm. Fergusson, is in the museum of the Royal College of Surgeons. Dr. David Foulis,[2] of Glasgow, has recorded the case of a man aged thirty, from whom he successfully removed a round-celled sarcoma involving the right side of the soft palate and tonsil, through an incision carried horizontally from the angle of the mouth, with division of the angle of the lower jaw.

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[1] Lancet, November 18, 1876.

[2] British Medical Journal, Oct. 12, 1878.

The hard palate, which resembles the gum in structure, is like it liable to *epuloid* growths of a fibrous nature, closely connected with the periosteum and bone, and therefore requiring free removal. The trephine was advantageously employed by Syme in a case of this kind, but, in the majority of instances, a superficial exfoliation produced with the cautery will give complete immunity from return, without causing subsequent deformity.

Epithelioma may invade the palate primarily, but more frequently it extends from the gums or tonsil. In the latter case its nature is readily recognized, but in primary epithelioma of the palate it may be difficult to distinguish it in the earlier stages, and the disease is often more extensive than at first sight appears. In a man lately under my care, who presented an epithelial ulcer confined apparently to the palate, which I destroyed with the actual cautery, I found extensive mischief spreading into the antrum, and recurring after free removal. When the disease begins in the alveolus, it spreads upwards into the antrum and along the palate, in the form of an out-standing growth and not in that of an ulcer. Hence the nature of the case is sometimes overlooked at first, and attention is apt to be concentrated upon the offensive discharge from the nostril, and other symptoms suggestive of suppuration in the antrum. Nothing, however, less than early and free removal of the whole disease can be of any service, and even then recurrence cannot always be prevented.

Diseases of the Gums.

Hypertrophy of the gums occurs as a congenital affection, and cases of it have been recorded by Gross, Salter, MacGillivray and others. In the Transactions of the Royal Medical and Chirurgical Society,[1] is a record of three children of one family who all presented hypertrophy of the gums, and who were also the subjects of *molluscum fibrosum.* All these children were of weak intellect. I brought before the Odontological Society of Great Britain, in 1878, two remarkable cases of hypertrophy of the gums, one in a child of five years, and the other in a young man of twenty-six. In the child the hypertrophy was general, involving the whole of the gums of both jaws, but in the young man it was partial, being confined to the gum and alveolus of the right side of the lower jaw, from the right wisdom tooth to the left canine. A cure was effected in both cases by removing the affected alveolus with the contained teeth, by means of powerful cutting forceps; and nothing less severe is effectual, since it has been shown by Mr. Charles Tomes that in these cases the disease dips into the socket of the teeth, and that therefore mere paring away of the redundant gum does not effect a cure.

A nævoid condition of the gum is occasionally met with as a congenital affection, and I have known it to coexist with an extensive port-wine stain of the face. In this patient, an otherwise healthy young woman, the nævoid growth appeared to take on greater activity with each pregnancy, and I removed the vascular outgrowth on two or three occasions, applying the actual cautery freely for the arrest of hemorrhage.

A vascular, non-congenital tumor of the gum may originate from irritation of the teeth, especially in the region of the incisors. When small, these growths may be treated with caustics, but if large and causing hemorrhage, they should be removed, and the surface from which they grow should be touched with the actual cautery.

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[1] Medico-Chirurgical Transactions, vol. lvi.

Polypus of the gum, or simple hypertrophy due to irritation, is not uncommon in the neighborhood of decayed teeth, or where an accumulation of tartar has been allowed to take place. The affection, when of considerable size, may resemble epulis, but differs from it in being unconnected with the periosteum; and hence it requires much milder treatment. The removal of the tartar or the decayed teeth, and the use of an astringent wash, are sufficient in most cases; if the growth is large, it is generally pedunculated, and therefore readily snipped off with scissors, or, if sessile, it may be cut off and cauterized with Paquelin's cautery. Salter describes a true warty affection of the gums, and also a condylomatous condition occurring in constitutional syphilis.

Gingivitis, or inflammation of the gums, is a common affection in infants who are cutting their teeth. The mouth is hot and tender, there being a constant dribbling of saliva, and the child's health is interfered with by the loss of rest, and by diarrhœa, and possibly convulsions, caused by the irritation of the system. Free lancing of the gums is the only trustworthy remedy, and should be had immediate recourse to in all cases of severity, although in slight cases rubbing the gums with the *syrupus croci*, or with one of the numerous but dangerously narcotic "soothing-syrups," may be sufficient.

A spongy condition of the gums, often called scurvy, but which differs entirely from the gum of true scurvy, is common in persons who neglect the cleanliness of their teeth, or who are in feeble health. According to Salter, the disease consists essentially in vascular dilatation of the papillary and other capillaries, with a general thickening of the gum itself. The treatment consists in improving the general health, and in using the tooth-brush vigorously with some astringent mouth-wash. The spongy gum due to the administration of mercury, differs from the preceding in presenting a well-defined red line along the margin of the gum, before the sponginess comes on, combined with fetor of breath, and a metallic taste in the mouth. The blue line of plumbism is due to a formation of sulphide of lead, and the green line of copper-poisoning to the oxidation of copper in the superficial tissues of the gum.

In *true scurvy*, due to deprivation of vegetable diet, the gums are swollen and livid from submucous extravasations of blood, and they bleed on the slightest touch. In advanced cases the gums become black and sloughy, protrude between the lips, and are horribly offensive. Such cases are seldom seen except in seamen who have been improperly fed and deprived of lime-juice during a long voyage; but mild cases of scurvy, characterized by subcutaneous ecchymoses in other parts of the body, may be met with, and like the more severe ones yield promptly to the administration of fresh fruit and vegetables. Bleeding from gums apparently healthy, is a common symptom in the hemorrhagic diathesis, and may be best checked by pressure and by the administration of hæmostatics in the form of iron and the mineral acids.

Transparent Hypertrophy of the Gums.—Under the name of *transparent hypertrophy*, Mr. Salter[1] has described a very rare affection of the gums, first noticed by the late Mr. Thomas Bell, F. R. S. "It consists in the slow and gradual hypertrophy of the extreme edge of the gum, at first like a cord, and very sharply marked from the immediately contiguous healthy-looking structure; but the most remarkable circumstance is the singular color of the hypertrophied part: it is pale pink and semi-transparent. It is very callous and insensitive, and scarcely bleeds when cut. As the disease progresses, the hypertrophy of the gum-edge increases, but it does not alter its character or lose its sharply defined limit. The teeth, when the affection exists, become slowly dislocated and pushed into irregular positions; they ultimately become very loose; when extracted, scarcely any blood flows. When the tooth is removed, the gum heals very slowly indeed, and the edge of the wound long continues of the same pale transparent aspect."

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[1] Dental Pathology and Surgery 1874.

Epulis is a term often used to include any form of tumor involving the gum, but may be conveniently restricted to the fibrous form which alone is strictly connected with the gum and alveolus. It is a slowly growing tumor, arising most commonly between two teeth which may or may not be decayed. By pressure it tends to separate the teeth if they are healthy, or it may completely cover in the stumps of decayed teeth. As epulis is closely connected with the periosteum of the alveolus, mere cutting away of the growth is insufficient for its eradication, and nothing less than cutting away the portion of alveolus from which it springs, or inducing its exfoliation by the application of the actual cautery, can be relied on. In order to do this, it is generally necessary to sacrifice the tooth on each side of the growth, and occasionally in removing the tooth the whole growth comes away, being in these cases attached to the peri-odontal membrane, instead of to the alveolar periosteum. An epulis, on section, is found to consist of dense fibrous tissue, closely resembling the normal gum, and it frequently contains masses of bone, which may or may not be directly continuous with the alveolus. According to Cornil and Ranvier, the common epulis is an ossifying sarcoma, the bone transformation being of an imperfect description.

Myeloid tumors are not uncommon about the alveoli (hence "myeloid epulis"), but are only the superficial portions of deeper growths. The remarkable feature about these growths is the dark color which is often to be seen on the surface of the gum-tumor previous to, or, more frequently, after removal. A very thorough and complete removal of these growths is necessary to insure a cure, and hence they are more properly classed among tumors of the jaw, which they commonly involve.

Papilloma occasionally affects the gums and requires free removal. Salter describes a case of the kind which occurred in Sir W. Fergusson's practice, and in which recurrence after removal had frequently taken place.

Ulceration of the gum occurs in children as the result of stomatitis,[1] but in the adult may be due to struma, syphilis, or epithelioma. Salter[2] narrates a case of *strumous ulceration* affecting the gums and palate in a youth of nineteen, of highly strumous diathesis, and thinks that the disease may be more common than is supposed. *Syphilitic ulceration* may affect the gums as well as other portions of the buccal mucous membrane, and occurs as a rule before middle age. *Epithelioma* affects the gums in patients over forty, and is often apparently connected with irritation caused by ill-fitting tooth-plates. Any ulceration in the mouth of an elderly patient which does not heal readily, should arouse a suspicion of epithelioma, and I insist upon this strongly, because, in the early stage, cases of this description are generally seen by dentists, who do not always appreciate the full gravity of the case and the necessity for prompt interference. When fully developed, the ulceration is ragged and irregular, and tends to spread from the gum to the cheek externally, or to the side of the tongue internally. The teeth in the neighborhood are loosened, and possibly the submaxillary lymphatic glands may be enlarged, as they always are in the later stages of the disease.

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[1] See p. 495.

[2] Op. cit.

Having treated several cases of epithelioma of the gum, I am convinced that nothing but very free removal offers the patient a chance of permanent relief. It is impossible to say how deeply in the jaw the epitheliomatous growth may have penetrated, and therefore it is better not to be content with simply cutting away the alveolus with bone-forceps, but to remove a piece of the whole thickness of the jaw, well beyond the disease. It is true that this leads to a permanent deformity, which one would gladly avoid; but to omit it is to almost court failure, with probable infiltration of the lymphatics, and a rapid termination. I have elsewhere[1] reported the case of a man, aged sixty-eight, from whom I removed the horizontal ramus of one side of the jaw, together with part of the floor of the mouth, for extensive epithelioma, who notwithstanding his age made a good recovery, and who presented himself two years afterwards in perfect health. Whereas in cases in which I have been content to remove the alveolus only, I have been often disappointed in the results. Any enlarged lymphatic glands beneath the jaw, may readily be removed at the same time, and thus an additional chance of immunity will be afforded. A remarkable example of extensive and successful removal of epithelioma of the lower jaw, was lately seen by me in a military man aged fifty-three, from whom Dr. Partridge, of Calcutta, had, in December, 1879, removed the left horizontal ramus with the submaxillary glands. Recurrence taking place at the chin, the right horizontal ramus and the glands were removed in March, 1880, by Dr. McCleod, also of Calcutta, and the patient returned to England, where I saw him in July, 1881, in perfect health; the parts were quite sound, there being one and one-half inches of space between the two halves of the jaw, and his only complaint being of a sense of tightness and want of saliva. He was alive and well in June, 1883.

Diseases of the Jaws.

Inflammatory deposit may take place in the *lower jaw* as a consequence of tooth irritation, and may rapidly lead to great swelling and deformity. When the tooth which has excited the inflammation is extracted, the swelling slowly subsides, but often some deformity exists for months; and it seems probable that some at least of the cases of fibroma found in the interior of the lower jaw, have originated in inflammatory deposit kept up and irritated by the presence of the fangs of carious teeth.

Alveolar abscess occurs in both jaws as the result of inflammation connected with the teeth, and originating in the socket. The earliest symptom is pain, with slight protrusion of the tooth, due to the inflamed condition of the membranes covering the tooth and lining the alveolus. If not relieved by judicious leeching or incision, matter forms in the socket, and either finds its way out by the side of the tooth, which is necessarily loosened, or, after causing great pain for a day or two, perforates the alveolus, and finds its way beneath the gum. This is the ordinary form of "gum-boil," which breaks spontaneously, after causing much suffering, unless previously relieved by a timely incision. The propriety of an early, free incision through the gum, down to the alveolus, is strongly to be insisted on, since necrosis and consequent exfoliation of large portions of the jaw not unfrequently follow neglect or postponement of the operation. Extraction of the tooth alone is not sufficient, where the alveolus has been perforated, and in many cases the incision will serve to preserve a useful though dead tooth for many years. The only accident which I have known to occur in connection with this operation, was the awkward one of a wound of the facial artery, from the edge of the knife being turned towards the soft tissues instead of against the alveolus.

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[1] Lancet, vol. ii., 1880.

But alveolar abscess does not always point within the mouth. The perforation of the alveolus may take place beyond the line of reflection of the buccal mucous membrane, and then the matter has to find its way to the nearest skin. In this way abscesses, with their resulting fistulæ, may be seen on any part of the face or neck; and occasionally grave errors of diagnosis are made from non-recognition of the fact that alveolar abscesses may burrow for long distances. I have known one instance of fatal suppuration between the muscles of the neck, leading eventually to suffocation, due entirely to mischief about a molar tooth in a patient whose health was undermined by drink; and it is common to see cases of fistulous opening, with serious scarring of the face and neck, due solely to the presence of a decayed tooth. In the case of the upper jaw, abscess connected with the incisor teeth not unfrequently finds its way backwards along the hard palate, and occasionally, but more rarely, into the nostril, being thus liable to be mistaken for discharge from the nose itself, or from the antrum.

Chronic abscesses have been met with in the substance of the lower jaw, depending no doubt upon osteitis, and presumably connected originally with tooth mischief. Since the swelling is the only evidence of the abscess, for it must be very rare for the bone to be sufficiently thinned to yield the crackling feel which is characteristic of contained fluid, it is not surprising that eminent surgeons should have removed large portions of the jaw in error, mistaking the tumor for a solid growth. Hence the rule, which should be invariably followed, to perforate tumors of the lower jaw before cutting the bone, since both abscesses and cysts closely simulate solid growths. In the case of a chronic abscess, the perforation alone, with efficient drainage, would be sufficient treatment.

Suppuration or empyema of the antrum is another form of chronic abscess, but with the peculiarity that the pus is seldom so completely shut in as to produce distension. In the great majority of cases, the matter constantly escapes by the anterior or posterior nares, and it is this discharge which first attracts the patient's attention. When escaping from the anterior nares upon the handkerchief, the discharge is apt to be attributed erroneously to ozæna, but the absence of the characteristic crusts and fetor sufficiently mark the distinction. In ozæna, the patient, as a rule, has lost the sense of smell, and is unconscious of his offensiveness; whereas, in cases of pus in the antrum, the patient is conscious of an occasional unpleasant odor, but is not disagreeable to his neighbors, though the discharge when blown on the handkerchief may be offensive. Often a patient suffering from pus in the antrum complains only of a disagreeable taste in the throat and mouth, on awaking in the morning, particularly if he sleep habitually on the side opposite to that of the affected antrum, the purulent fluid then slowly flowing backwards into the pharynx and being partially swallowed, with great detriment to the digestion.

In the exceptional cases where the opening into the nose is closed, the pus tends to accumulate and produce distension of the antrum, with absorption of the bony walls, by which the characteristic crackling is produced. It may be doubted, however, whether some at least of these cases are not instances of cyst of the wall of the antrum, the contents of which have become purulent.

In cases of distension the pain is severe, and of a neuralgic and intermittent character; but in the ordinary form of the disease, there is little more than an occasional sense of uneasiness and weight about the jaws, so indistinct as often to be no guide to the side on which the mischief exists.

In the great majority of cases, empyema of the antrum depends upon inflammation of the lining membrane of the cavity, caused by the fangs of decayed teeth, which, if not actually perforating the membrane, are in close proximity to it, either from unusual depth of the sockets or from absorption of the intervening, thin portion of bone. It is possible, however, that the mischief may be set up by extension of catarrhal inflammation from the nose, by blows on the face, or even by the pressure during birth, in the case of an infant. A careful examination of the teeth will, in most cases, show which of them is in fault, and, though the first and second molars are those of which the fangs most frequently cause mischief of this kind, it must be remembered that the canine frequently, and the incisors more rarely, are connected with an unusually extensive antrum. The extraction of a decayed tooth or fang may be followed by an immediate discharge of pus, in which case an enlargement of the opening will probably be required; but frequently the tooth which has set up the mischief has been long extracted, and it then becomes necessary to perforate the antrum above the alveolus. For this purpose a drill, a gimlet, or an ordinary trocar of medium size may be employed. If the bone happens to be thin, any instrument passes through readily, and the operator is aware that he has entered a cavity, and may, if he does not hold the perforator judiciously short, transfix it and come in contact with the orbital plate. But in many cases the bone is extremely dense, and the instrument is gripped so tightly that it is impossible, until it is withdrawn, to be sure that the cavity of the antrum has been reached.

Whether the perforation be made through or above the alveolus, an ordinary Eustachian catheter of silver or vulcanite will be found very convenient for washing out the antrum, and a simple India-rubber ear-syringe with a bullet-joint will be sufficiently powerful for the purpose. Ordinarily, fluid injected through the perforation flows readily from the nose, bringing away a quantity of more or less inspissated pus of offensive character; but occasionally the cavity of the abscess does not communicate with the nose, and the fluid must then be allowed to flow back by the perforation.

The after-treatment of these cases consists in maintaining the aperture patent, which is often difficult, until all purulent secretion has ceased; in washing out the cavity at least thrice daily with warm Condy's fluid and water; and in throwing in a small quantity of stimulating lotion, such as two grains of sulphate of zinc in a fluidounce of rose-water. When the opening is above the alveolus, there is little danger of particles of food entering the cavity, but when the opening is through the alveolus, food will readily penetrate, unless an artificial denture be applied so as to cover the opening during mastication. When a dental plate is employed, a silver tube should be fitted to the perforation so as to maintain its calibre, and thus the occasional introduction of a trocar, which would otherwise be necessary, may be dispensed with. Still, it must be allowed that the cure of empyema of the antrum is often very tedious, and that many months may elapse before a patient can dispense with daily washing out of the cavity.

Since, as has already been said, distension of the antrum with facial deformity occurs only when the accumulating matter does not discharge into the nostril, it is easy to mistake a case of this kind for a solid tumor of the upper jaw, should the amount of distension not be sufficient to produce much thinning and crackling of the bone. Again, it appears possible that the fluid portion of the matter contained in the antrum may drain away, leaving behind it a solid mass of inspissated pus and cholesterine, which, as in a case of my own, may, by its presence, induce partial absorption of the floor of the antrum, with a protrusion of the palate and all the symptoms of maxillary tumor. In order then to avoid an error which has overtaken very excellent surgeons, it is advisable, in all cases of tumor of the upper jaw in which the nature of the swelling is not obvious, to perforate the antrum beneath the cheek, before incising the skin of the face and taking the necessary steps for removal of the jaw.

The *secondary effects produced by distension of the antrum* are sometimes serious. Thus, protrusion of the eyeball from elevation of the floor of the orbit is not infrequent, and cases of permanent amaurosis have been recorded by Salter and Gaine, while occasionally death has been known to follow suppuration within the antrum.

PERIOSTITIS, both acute and chronic, affects the jaws, but the former is so prone to run into suppuration with consequent necrosis, that it is only in the early stages that it can be recognized. The more chronic form is commonly connected with syphilis, and leads to the formation of nodes about the palate, and to enlargement of portions of the lower jaw. In these latter cases, the administration of the iodides in full doses gives most satisfactory results. Many cases of persistent facial neuralgia which are unrelieved by quinine, etc., yield to the administration of iodide of potassium, and may be concluded to depend upon chronic periostitis or osteitis, with probably pressure upon the dental nerves.

NECROSIS affects the lower much more frequently than the upper jaw, probably in consequence of its being less abundantly supplied with blood. Beginning as periostitis from tooth irritation, injury, or the action of some specific poison, the general symptoms are pain, with pyrexia, and the part affected will be found to be swollen, injected, and hot, the teeth being raised from their sockets, and unable to bear the slightest pressure. If relieved by timely depletion by leeches or, better, a free incision, and the assiduous use of hot gargles and poultices, the symptoms may subside without further mischief; but usually matter has already formed beneath the periosteum before the patient is seen, and then, although promptly evacuated, necrosis is very apt to follow. Fortunately, necrosis sometimes affects the outer plate of the alveolus only, so that the teeth are supported by the inner plate and can be kept *in situ;* but when the entire socket is involved, the teeth are rendered loose and useless, and are better away, since they only plug the openings through which the discharge would find its way out. It is very undesirable to attempt removal of sequestra until they are completely loosened, since by doing so damage may be inflicted on the surrounding parts, and the process of repair be interfered with; and this is especially the case with children in whom the second teeth are still undeveloped. It is impossible to lay down any rules for the period of separation, which must depend upon the extent and position of the sequestrum, and the strength of the patient; but ordinarily, from six weeks to three months must elapse before large sequestra can be safely extracted.

By *exanthematous necrosis* (Salter), is meant the necrosis occurring in young children, for the most part after attacks of the specific fevers, especially scarlet fever and smallpox. Necrosis of portions of the alveolus of either jaw, and usually on both sides symmetrically, or even of the whole thickness of the lower jaw, is fully recognized now as one of the sequelæ of these disorders; and doubtless many of the cases which were attributed to the administration of calomel, in former days, were really due solely to the action of the specific poison. The course and treatment of these cases differ in no respect from those of ordinary necrosis.

The action of the fumes of *phosphorus* in producing necrosis of the jaws in persons employed in lucifer-match making, has now been recognized for upwards of forty years, Lorinser being the earliest writer upon the subject in Germany. The work of Von Bibra and Geist, of Erlangen (1847), and the Report to the Privy Council, by Dr. Bristowe (1863), give the best accounts of the disease, which is now becoming rare, owing to the precautions taken in the manufacture of lucifers.

It was found that, as long as workers among phosphorus had perfectly sound teeth, their health remained unaffected; but that as soon as the teeth became carious, or were from any cause extracted, the fumes of phosphorus found their way to the periosteum of the jaws, and excited periostitis with rapid necrosis. The symptoms were severe, the swelling of the jaws and tissues of the face being extreme, and the discharge of purulent fluid from the mouth being constant and in large quantities. The general health became secondarily affected, the patient being worn out with pain and inability to take solid food, and in very severe cases being liable to gangrene of the gums and cheeks. All these discomforts have been put an end to by insisting upon cleanliness in the use of the phosphorus, by the careful examination of the mouths of the workers, but most especially by the employment of the amorphous phosphorus in the manufacture of lucifer-matches.

The remarkable point about phosphorus necrosis is the peculiar deposit of pumice-like bone which takes place upon the sequestra. This is doubtless derived from the periosteum, although so closely adherent to the sequestrum as to be invariably brought away with it; and though resembling true bone in some particulars, it is of a decidedly lower development. A form of bone closely resembling this pumice-like deposit has, however, been noticed in cases in which no phosphorus was involved, and it would appear that in some instances, possibly of rheumatic origin, the deposit of new bone partakes of this character. Whenever it does, it can in no way tend to the repair of the necrosis, for the deposit is always firmly adherent to the sequestrum, and must be removed with it.

Besides phosphorus necrosis, *mercurial necrosis* was once common, not only as a consequence of the excessive administration of mercury for antisyphilitic purposes, but as a result of the destructive ptyalism produced by the fumes of liquid mercury, as formerly employed in the manufacture of looking-glasses. When glass plates were converted into mirrors by sliding and compressing them on to sheets of tinfoil covered with pure quicksilver, the men employed were liable to have their teeth drop out, and frequently lost portions of their jaws, their lives being notoriously shortened. Since the introduction of a chemical process by which the mercury is deposited on the glass, these cases of induced necrosis have become almost unknown.

In ordinary cases of necrosis of the upper jaw, no reproduction of bone takes place, the gap left in adults being permanent, though in children, the subjects of exanthematous necrosis, the granulation-tissue is slowly converted into fibrous tissue, which does not, as a rule, ossify. In the lower jaw, abundant new bone is produced by the periosteum, and, for a time at least, most extensive losses are repaired. The museum of the Bellevue Hospital, New York, contains a remarkable illustration of this in a large phosphorus sequestrum, extracted by the late Dr. J. R. Wood from a girl who survived three years, and in whom reproduction of a semicircle of new bone, about five-eighths of an inch broad, with all the epiphyses, took place (Erichsen). It is certain, however, that, in the course of years, a great, if not complete, reabsorption of the new bone thus formed takes place, the patient being left ultimately with very little, if any, support for artificial teeth. Salter has suggested that the early application of artificial teeth would tend by use to strengthen and maintain the permanence of the new bone; but there are no facts to support this view.

HYPEROSTOSIS OF JAWS.—Under the name *hyperostosis*, may be conveniently grouped together a number of cases in which general enlargement of the maxillary bones occurs, without any distinct tumor which could be properly placed among the osteomata. Enlargement of the angles of the lower jaw, quite unconnected with the development of the teeth, and giving a peculiarly broad appearance to the face, occurs in otherwise healthy subjects of about twenty, and these enlargements appear to remain stationary. In true hyperostosis, however, there are large bosses of bone, often symmetrical, thrown out by the bones of the face and cranium, which slowly but steadily increase in size, producing hideous deformity, and ultimately causing the death of the patient. Howship, Cooper, and Bickersteth have recorded remarkable instances of this affection, which appears to be unconnected with syphilis, and to be unaffected by medicines. Cases in which the disease is unilateral, may fairly be submitted to operative proceeding, and I have twice relieved patients from considerable deformity by sawing or gouging away a portion of the projecting bone without any external incision. In one case, that of a lady aged thirty-nine, the enlargement of the right upper jaw was attributed to a blow on the cheek; in the other, that of a man aged forty-six, the enlargement in the same situation came on apparently without cause. Sir James Paget has recorded[1] some cases of *osteitis deformans*, affecting many of the bones of the body, including the skull, which closely resembled in some particulars the cases recorded by other surgeons as hyperostosis; but in these, as also in cases recorded by Dr. Cayley and Dr. Goodhart,[2] cancer of some sort was present in addition. This would appear to place these cases of general osteitis deformans in a different category from those in which the disease is confined to the bones of the skull or face, and in which, as far as is known, no cancer has been found.

ODONTOMA, or tooth-tumor, is the name given by Broca to the group of cases in which the tumor consists of tooth-elements more or less hypertrophied. The majority of these are outgrowths from the pulp of well-formed teeth, or at least have their connection with the teeth well marked, and may therefore be more properly considered in the pages devoted to dental surgery. There is one form of odontoma, however, which is strictly surgical, since it is apt to give rise to serious mistakes in the diagnosis and treatment of one form of tumor of the jaw. This depends upon some modification of the germs of one or more of the molar teeth of the lower jaw, before the development of the cap of dentine, leading to the formation of an irregular mass of dental tissues in no way resembling a tooth in shape. These cases are very rare, and occur only in the lower jaw. The symptoms are those of a dense tumor expanding the bone, in which there is no pain, unless the mass should interfere with the development of the wisdom-tooth, or be mistaken for a misplaced tooth or a sequestrum, when acute inflammation may be excited in the jaw itself by ineffectual attempts at removal. Very eminent surgeons have been misled by these cases, and have unnecessarily sacrificed portions of the lower jaw, when, as experience has shown, enucleation of the growth could invariably have been undertaken with success. I have recently had under my care a case of this kind, in which persistent efforts to remove what was supposed to be an impacted tooth had given rise to so much inflammation about the jaw and gums, that, when I was first consulted, I believed the patient to be suffering from a rapidly growing tumor of the interior of the jaw, and recommended removal of a portion of the bone. Fortunately, on the subsidence of the inflammation the case more resembled one of necrosis, and, on attempting to search for and remove a sequestrum, I was enabled to enucleate an odontoma measuring one and one-half inches by one and one-quarter, and weighing three hundred and fifteen grains.[1] The tumor consisted of dental tissues irregularly arranged, and represented one or two molar teeth.

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[1] Medico-Chirurgical Transactions, vol. lx.

[2] Pathological Society's Transactions, vol. xxix.

Displacement of otherwise healthy and well-formed teeth may give rise to enlargement of either jaw, and even supernumerary teeth have been known to form distinct tumors connected with the maxillary bones. Such cases must necessarily be very difficult of diagnosis, and are best treated by exploration before any serious mutilation is undertaken.

Cysts of the Jaws.—The developments of *cysts* in connection with uncut teeth is a subject of great practical importance for the surgeon, since mistakes in the diagnosis and treatment of these cases are far from rare. *Dentigerous cysts* may occur in either jaw, a tumor being gradually formed, the growth of which is slow and for the most part painless. A careful examination of the neighboring teeth will be the best guide to a correct diagnosis, for, if a tooth be absent, or, as sometimes happens, if a temporary tooth occupy the position of a permanent one, the tumor in all probability is a dentigerous cyst, and no mutilating operation should be undertaken without first opening up the tumor to discover its nature.

Dentigerous cysts arise in connection with teeth which from some cause have remained within the jaw, and have undergone a certain amount of irritation. They are most commonly connected with the permanent teeth, though I have met with a cyst in a boy of four, in whom a temporary canine tooth was wanting, and on cutting into the cyst I extracted seven small, irregular nodules of dentine and enamel. Frequently the tooth in fault is inverted, but often there is nothing to explain the formation of the cyst, which is apparently due to the increase in quantity of the small amount of fluid ordinarily found in the tooth-sac after the completion of the development of the enamel. The cyst-wall is usually too dense to give rise to the crackling so characteristic of the presence of fluid within, and is lined by a thick, vascular membrane. Usually the tooth projects through this membrane, but I have met with a case in which a large cyst of the lower jaw was carefully searched in vain for a tooth, which however made its appearance some weeks after, when the membrane had been to a great extent destroyed by suppuration.

Dentigerous cysts have been mistaken for solid growths on many occasions, one of the most remarkable specimens of the kind being one side of the lower jaw, removed in error from a girl of thirteen by the late Mr. Fearn, and now in the Museum of the Royal College of Surgeons of England. Here the two plates of the lower jaw are expanded from the angle on the left to beyond the symphysis on the right side, forming a bony cyst, the cavity of which is lined with a thick, vascular membrane through which a well-formed, permanent canine tooth projects.

The treatment of these cases of dentigerous cyst is sufficiently simple when once a diagnosis has been made by an exploratory puncture. The removal of a portion of the cyst-wall, so as to allow of a search for and the removal of the hidden tooth, is all that is necessary, the cyst shrinking down as soon as a free vent for the contained fluid is secured. Occasionally the contents of these cysts have suppurated before being opened, and in all cases care should be taken to use antiseptic lotions, and to insure cleanliness by syringing. Cysts in connection with fully developed teeth undoubtedly occur, although possibly some of the so-called cysts are nothing more than abscess-sacs, which follow the fangs to which they are attached when these are extracted. The only post-mortem examination of such a case is one recorded by Fischer, of Ulm, who, after removing the facial wall of the antrum, found a cyst connected with the apex of the last molar tooth, which filled the whole cavity.

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[1] Transactions of Clinical Society, 1882.

But cysts of the upper jaw are by no means uncommon in which no connection with the teeth can be made out, and which certainly do not fill or in any way occupy the antrum. In fact, it may be doubted whether the old term *hydrops antri* is not altogether a misnomer, the cases which have hitherto been grouped together under that name being either cysts of the wall of the antrum, or cysts altogether outside the antrum, which push in its wall as they develop. The history of these cases is one of gradual, painless dilatation of some part of the upper jaw, usually close above the alveolus, the bony wall becoming so thin as to crackle like parchment, or eventually becoming simply membranous, in which case a characteristic, bluish appearance is seen on lifting the lip, and fluctuation can be readily perceived. On incising such a cyst, a quantity of dark-colored fluid of varying consistency escapes, and the finger passes into a smooth cavity not perforated by the fangs of teeth, and quite outside the antrum. By cutting away a portion of the cyst-wall, so as to insure free drainage, the cure of the cyst is gradually brought about, but very slowly. The same form of cyst occurs, but less frequently, I think, in the lower jaw.

In the earlier stage of the complaint, when the jaw is distended, but when absorption is not so far advanced as to make the nature of the case clear, a puncture with a trocar will probably evacuate cystic fluid, often containing cholesterine, and differing entirely from the mucous secretion of the lining membrane of the antrum. A remarkable specimen in the King's College Museum, figured in Fergusson's Practical Surgery, shows complete absorption of the front wall of the antrum, with great distension of the cavity, which does not communicate with the nose; but it is impossible to tell whether this was originally a case of empyema, or one of so-called hydrops antri.

Adams, Giraldés, and Luschka have shown that both single and multiple cysts develop occasionally from the wall of the antrum and project into the cavity, and that polypoid growths form in the same situation. A recent case recorded by Sir James Paget,[1] supplies a symptom of such polypoid growths hitherto unnoticed, viz., the constant flow, from the nostril of the affected side, of clear watery fluid in considerable quantity. The patient, a lady, aged forty-nine, suffered for nearly two years from this inconvenience, and was then relieved, and ultimately cured, by the use of sulphate of zinc, locally and internally, as recommended by Brodie in a similar case. The patient dying from causes unconnected with the antrum, its "floor was found to be covered with two broad-based, convex, polypoid growths, deep, clear, yellow, with the fluid infiltrated in their tender tissue. They looked like very thin-walled cysts, but were formed of very fine membranous or filamentous tissue infiltrated with serum."

Cysts occur in the lower as in the upper jaw, and may be single or multiple. These cysts probably originate in the cancelli of the bone, and are in many cases due to the irritation caused by neighboring teeth; a cancellus, being filled with fluid, expands, and produces gradual absorption and obliteration of neighboring cancelli, until a cyst of considerable size is produced. One of the largest known is in the Museum of St. George's Hospital; it is figured in Holmes's System of Surgery. It extends from the symphysis to the condyle on the right side, and had existed for eighteen years. The multilocular cysts of the lower jaw appear to be more closely connected with the teeth than the single cysts, since in many cases the extraction of teeth or stumps gives exit to a quantity of glairy discharge. Distension and absorption of the alveoli go on as the cysts increase in size, so that the walls at length become membranous, and the macerated bone shows great gaps in its outline. One remarkable clinical feature in these cases is the length of time over which they extend without materially affecting the health of the patient, except by their size and the consequent inconvenience produced. I have recently put on record[1] the history of a cystic tumor of the lower jaw, extending over thirty years, the patient having had a portion of the right side of his jaw removed by Sir Wm. Fergusson in 1847, and having remained in good health for fifteen years. He then noticed the formation of a cyst in the incisor region, which was tapped from time to time by Sir Wm. Fergusson. The patient came under my care in 1877, when I found cystic disease of the symphysis and left side of the body of the jaw, extending up to the molar teeth. I then extracted all the remaining teeth and opened up the cysts freely, crushing in the walls and removing some solid material with the gouge. Considerable consolidation followed this proceeding, but a year afterwards a fresh development of cysts had taken place, and required a repetition of the operation, which was on this occasion followed by such good results that early in 1879 the jaw was completely consolidated, and the patient able to wear artificial teeth. Late in the same year, a rapidly growing, round-celled sarcoma developed in the jaw, and was removed, but similar tumors developed in the humerus and pelvis, and the patiently gradually sank in 1880.

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[1] Clinical Society's Transactions. 1879.

The liability of multilocular cysts of the lower jaw to develop eventually solid tumors of an epithelial type, has been recently illustrated in my own practice in another case; and also in a case of so-called cystic sarcoma, I have seen, eleven years after, a recurrence in the skin of an epithelial cancer. These facts have led me to accept the views founded upon a microscopical examination, by Mr. Frederick Eve, of tumors removed by myself and others, in the Museum of the Royal College of Surgeons, which views are given at length in a lecture delivered at the College in 1881.[2] Mr. Eve maintains that cases of multilocular cyst and of cystic sarcoma should be grouped together as examples of epithelioma; and if that be so, there can be no question that complete removal of the affected portion of jaw should be promptly undertaken, if any solid growth is found in connection with the cysts.

Mason Warren and Butcher have shown that by evacuating the contents of the cysts from within the mouth, and crushing in the thin walls with the fingers, a great amount of consolidation can be brought about, and, if the thick lower border of the jaw be unaffected, as it usually is, a very firm basis of support for artificial teeth may thus be obtained. The operation may bear repetition more than once in the early stage of the cystic disease, but is certainly unsafe as soon as the development of an epithelial tumor begins to show itself, when more radical measures must be adopted.

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[1] British Medical Journal, May 22, 1880.

[2] Ibid., January, 1882.

Tumors of the Jaws.

The progress of pathological investigation has, of late years, considerably modified the views held by surgeons as to the nature of many of the tumors found in both the upper and lower jaws. Modern methods of investigation have thrown doubt upon those formerly employed, and hence but little confidence can be placed in many of the earlier-recorded microscopic appearances of maxillary tumors. Fairly reported clinical histories must always be of value, but in the light of modern pathology it is impossible in many cases to reconcile the clinical history with the pathological interpretation. In the following pages, an attempt will be made to classify tumors of the jaws in accordance with modern histology; and for assistance in this endeavor I am indebted to Mr. Rushton Parker, of Liverpool, and to Mr. Eve, Curator of the Museum of the Royal College of Surgeons of England.

Among *non-malignant tumors*, or tumors composed of one of the modifications of fully-developed connective tissue (Erichsen), we may recognize fibroma, enchondroma, and osteoma.

Fibroma.—This is found in the upper and lower jaws in the form of the hard fibrous and the softer fibro-cellular tumor. According to Broca, both the fibrous and fibro-cellular tumor may be of dental origin, forming one variety of odontoma, which is found in young persons only, and which has the peculiarity of being encysted and therefore easily removed. I have only met with one case which seemed to support this view, in the person of a young lady who had a tumor of the upper jaw, evidently due to expansion of the antrum, the walls of which crackled under pressure. Believing the swelling to be due to fluid, I punctured it, giving exit to a small quantity of liquid, and discovered a tumor within. On laying open the antrum, I was able to enucleate with the finger a tumor which had very slight attachments, presenting all the appearances of a fibrous tumor, but microscopically found to be very rich in cell elements and therefore likely to recur. Nevertheless, the patient is now in perfect health ten years after the operation.

Fibroma of the jaws closely resembles fibroma in other parts of the body, and especially the uterus. It is dense in structure and frequently lobulated, and on section shows interlacing bundles of fibres. Two varieties of origin are found: the periosteal, springing generally from the alveolus, and indistinguishable except by its size from epulis; and the endosteal, which springs from the interior of the bone, and in the upper jaw generally makes its way into the antrum and nasal cavities, or, in the lower jaw, expands the inner and outer plates of compact bone. Fibroma produces absorption by pressure, and may thus destroy a great part of the skull; it stretches the skin of the face, and may by tension produce ulceration, and thus cause an aperture, but it never involves the skin, which is always loose and movable over the tumor. The enormous size to which fibromata may grow without destroying the patient's life, is well seen in some of Liston's and Fergusson's cases, but such tumors are rarely met with nowadays. The disease never gives rise to secondary deposits, and if freely removed, so that all prolongations with the Haversian canals of the neighboring bone are got rid of, does not recur. Fibroma of the jaw may undergo calcareous transformation, as in the uterus, and occasionally the calcareous matter may become necrosed and cause suppuration. Suppuration is also found occasionally in connection with simple fibroma, but only when it has been punctured for diagnostic purposes, or otherwise irritated.

Fibroma appears to owe its origin in many cases to the irritation of decayed teeth, which may sometimes be found imbedded in the tumor, or displaced by it. No treatment less radical than the removal of the portion of bone from the periosteum of which the tumor springs, can be of avail in the periosteal variety of fibroma, but in the form in which the bone, and particularly the lower jaw, is expanded by a slow-growing tumor within it, less heroic measures may be successful. I have already referred to a case in which I removed a fibroma from within the antrum by enucleation, with complete success, and numerous museum specimens serve to show that the lower jaw is often expanded |by fibrous tumors which are amenable to this treatment. Sir James Paget[1] has strongly recommended the adoption of the practice of enucleating non-malignant tumors of bone, in all parts of the body, and it is one decidedly to be followed in suitable cases.

Enchondroma is of less frequent occurrence in the jaws than fibroma, and like it may be either periosteal or endosteal. The tumor appears, ordinarily, early in life, springing from the surface of either jaw, or from within the antrum or the interior of the lower jaw, and grows steadily, and more rapidly than a fibroma. It is more tuberous and harder than a fibroma, and in the case of the upper jaw is apt to send processes into the fissures and cavities of the skull, thus giving rise to great deformity by involving the nose and orbit. Many remarkable specimens of this kind are to be found in museums, the patient in some cases having been suffocated by the growth involving the mouth and pharynx. And yet, in these cases, it will be seen that the tumor does not invade the surrounding parts except by its pressure, and could have been enucleated. Enchondroma has undoubtedly a greater tendency to recur locally than has fibroma, and it is essential therefore in its treatment that free removal should be practised. Mr. George Lawson[2] has recorded a case of enchondroma of the lower jaw upon which Sir W. Fergusson operated six times, recurrence taking place on each occasion, and eventually leading to the formation of a large mass weighing eighteen ounces, which Mr. Lawson successfully removed. I have also recorded[3] a remarkable instance of repeated recurrences of a cartilaginous tumor, extending over five and twenty years; the patient died of erysipelas, and no secondary deposits were found in the internal organs. Cases of deposit in the lungs, which have been from time to time recorded after the removal of enchondromata, have been doubtless examples of "chondro-sarcoma," an affection which will be considered hereafter, and which has but recently been differentiated from simple enchondroma.

Enchondroma of the jaws may have fibrous tissue mixed with it, or may in great part be converted into bone; and no doubt many of the remarkable osseous tumors of the jaws to be found in museums, were originally cartilaginous in their nature.

Osteoma is found in the jaws as a cancellous or as an ivory tumor. The simplest form is the condensed hypertrophy due to the presence of a misplaced tooth, and the fact that numerous serious operations have been performed in these cases, should make the surgeon especially careful as to his diagnosis. The cancellous osteoma has a covering of compact bone of varying thickness, but sometimes so thin as to crackle under the finger. It grows slowly to a very large size, as may be seen in a remarkable specimen in the Musée

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[1] Medico-Chirurgical Transactions, vol. liv.

[2] Lancet, June 8, 1878.

[3] Injuries and Diseases of the Jaws, p. 244.

Dupuytren, at Paris, but when removed by section of the healthy bone beyond, shows no tendency to reproduction.

The ivory osteoma I have met with both as an outgrowth from the lower jaw of a healthy woman, and as a tumor of the upper jaw of which the ivory was but a portion, the rest being composed of dense cancellous bone. Some very remarkable cases of osteoma which are on record, are doubtless examples of ossified enchondroma. In these cases the tumor has a tendency to become loosened from its attachment to the surrounding parts, and either to drop away, as in Mr. Hilton's case, or to be readily removed, as in Dr. Duka's.

In the treatment of these tumors, an exploratory puncture, or trephining, may enable the tooth which is the cause of the malady to be extracted, and hence this should never be neglected except in the case of the ivory growth. This again may be sawed off, showing no tendency to recur, or it may be extracted from the cavity of the antrum, or from the interior of the lower jaw. As a last resource the upper jaw, or a portion of the lower, may be removed with the tumor, but extensive mutilations should not be undertaken for benign and slowly increasing tumors if they can be avoided.

PULSATING TUMORS of the upper jaw have been occasionally met with, and are mostly examples of vascular sarcoma. In the Museum of University College, London, is a specimen of true erectile tumor of the upper jaw and pterygo-maxillary fossa, removed in 1841 by Mr. Liston from a man aged twenty-one, who had suffered from frequent hemorrhages from the growth. The tumor is everywhere bounded by a dense layer of fibrous tissue, but "on section the divided surface has a uniformly open, cavernous structure, like that of the corpus cavernosum penis, the meshes of which are nowhere occupied by a solid substance, and probably allowed of the circulation of blood through them."

CYSTIC SARCOMA.—Under the old term "cystic sarcoma," were included probably more than one variety of solid growth in which cysts were developed. The presence of cysts was held to mark the non-malignant character of the disease, and the clinical histories of the recorded cases appeared to support this view. The naked-eye appearance of the solid growth was that of a fibrous or fibro-cellular tumor, and this was considered to be its nature until within a few years. In 1871, Mr. Wagstaffe[1] described a tumor of this kind as consisting of a peculiar arrangement of what appeared to be acini or cylinders of closely-packed cells, supported by a fibro-nucleated matrix. In the same year, I removed a large cystic sarcoma involving the right side of the lower jaw, which presented many of the appearances described by Mr. Wagstaffe, and led Mr. Beck to describe the tumor, in the Catalogue of the Museum of University College, as a peculiar, "gland-like tumor of bone," affecting only the lower jaw. One-half of this tumor having been presented to the Royal College of Surgeons, has recently undergone fresh examination by Mr. Eve, the curator, who from his investigations upon it and other similar tumors, has come to the conclusion that they originate in an ingrowth from the epithelium of the gum, and should be classed among the epitheliomata. He would attribute the development of cysts to degeneration of the epithelial cells, and the apparent immunity from recurrence to the fact that these tumors are more or less completely encased in a shell of bone. I was hardly prepared to accept this view in its clinical aspects, when, early in 1882, the patient from whom, in 1871, I had removed nearly the whole of the right side of the lower jaw for "cystic sarcoma," reappeared with a large ulcer of the cheek, presenting all the appearance of epithelioma. Upon removing this, by cutting freely around it, I found it connected strongly and deeply with the coronoid process and condyle of the lower jaw, which I had not removed at my former operation, thinking it unnecessary to do more than go well beyond the disease. This case then goes far to confirm the view that "cystic sarcoma" is really epitheliomatous in its origin, and that its removal should be as free as in cases of more fully recognized epithelioma.

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[1] Pathological Transactions, vol. xxii.

But a much wider question is thus opened up, viz., whether, as Mr. Eve believes, cases of multilocular cyst in the lower jaw, accompanied, as they usually are, by more or less solid growth, are also examples of epithelioma. In his Erasmus Wilson Lectures for 1882, Mr. Eve has fully discussed this question, and certainly the fact recorded by myself on a preceding page, of a solid tumor forming after a thirty years' existence of cystic disease, would tend to show that the malady in question is not as harmless in its course as has hitherto been supposed. Still, the clinical history of these cases, and also of the cases of ordinary "cystic sarcoma," differs so completely from that of ordinary epithelioma as to rapidity of progress and recurrence after removal, that further observation is necessary before a decided opinion can be arrived at on the whole question.

Sarcomata.—Under the term sarcoma, modern pathologists include all tumors composed of tissue which is either embryonic, or which is undergoing one of the primary modifications seen in the development of adult connective tissue (Erichsen).

In connection with the jaws, various forms of sarcoma are found, many of which have hitherto been known by other names; and many recurrent growths, formerly called cancers, come properly into this class.

1. *Spindle-celled sarcoma* is of frequent occurrence about the jaws, forming many of the specimens formerly indiscriminately named "osteo-sarcoma." Under this heading must be included also the "recurrent fibroid" cases, reported by Mr. Holt and Mr. Lawson, in the last of which recurrence took place after three operations, and led—as may be seen in the specimen, which is preserved in the museum of the Royal College of Surgeons of England—to enormous reproductions of the disease in the maxillary and temporal regions.[1]

The principal clinical features of spindle-celled tumors of the jaw are rapidity of growth, with invasion of surrounding parts, but no glandular infiltration, at least in the earlier stages. Free removal is essential, because of the tendency to creep along the periosteum beyond the defined tumor, which is common in these cases; and recurrence is frequent. A remarkable feature in the recurrent growths is their tendency to become softer with each recurrence, until the patient dies, worn out, with, rarely, secondary deposits in internal organs. In 1867 I removed a very large tumor, probably of this kind, which in its growth had destroyed the entire body of the lower jaw of a man aged 32. The tumor is in the Hunterian Museum, and a wax model, made soon after its removal, is in University College, London. It is of an irregularly oval shape, measuring antero-posteriorly eight inches, and from side to side about five inches. A tumor had been present in the jaw for some years, but had latterly grown rapidly under the application of quack remedies, and, when the patient came under my notice, he was nearly starved from the projection of a great mass of the growth into his mouth. The jaw, with the tumor, was removed by disarticulating on one side and sawing through the ramus on the other, without any great loss of blood, but the patient died on the sixth day.[2]

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[1] Pathological Transactions, vol. xi.

[2] Lancet, Dec. 21, 1867.

This tumor has recently undergone a fresh examination by Mr. Eve, who believes it to be an example of a combination of sarcoma with epithelioma, of which, as far as is known, it is a unique specimen.

2. *Round-celled sarcoma* (the encephaloid sarcoma of Cornil and Ranvier, and others) is a more vascular and softer growth, and hence has more of the characters of a "malignant" tumor. It grows very rapidly, invading the skin and forming fungous protrusions, and leads to deposits in internal organs. Many of the recorded cases of "medullary" cancer of the jaw belong to this class. In the Museum of University College, London, is the head of a woman, aged twenty-four, who came under my care in 1868 with an enormous development of round-celled sarcoma in the bones of the face, invading the orbits and cranium. This originated in a growth on the margin of the orbit, which had twice been removed by Sir W. Fergusson, and had again recurred. In a child of five, who was also under my care, a large tumor of the lower jaw had grown in seven weeks, when I removed it with the right side of the lower jaw. Recurrence took place in six weeks, when I again operated, removing a further portion of jaw, with a fungous growth on the skin. Within three months the disease again recurred, and destroyed the patient in less than six months after its first appearance.

3. *Myeloid sarcoma* has long been recognized in relation with the jaws, in which situation it was originally described by Paget. It is found in connection with the alveolus, forming the so-called myeloid epulis, and also in the interior of the lower jaw. Occurring in children or young adults, the myeloid growth springs from the interior of the alveolus, and protrudes between the teeth, which may be displaced. The growth is softer than the fibrous epulis, and more vascular, and occasionally presents characteristic dark spots beneath the mucous membrane. Or, when developed deeply in the interior of the lower jaw, it expands the bone without forming an external protrusion. The development of cysts is not infrequent in the interior of the growth, which may pulsate. A section of the tumor shows the maroon color resulting from hemorrhage within the tissue, so common in myeloid growths.

The question of recurrence in connection with myeloid growths is a very important one; and it may be considered that after complete removal, recurrence does not take place. In 1875, I removed a myeloid tumor from the interior of the lower jaw of a gentleman, aged nineteen, by free gouging, but without dividing the jaw. Recurrence took place, when I again operated very freely, leaving nothing but the thick lower border of the bone, and since then the patient has remained well. A remarkable case in which myeloid tumors of both angles of the lower jaw were present in a boy of seven, was successfully operated on by me some years ago, and I believe that the patient has remained well since.

4. *Alveolar sarcoma* occasionally affects the jaws, and in the Museum of the Royal College of Surgeons of England, will be found a specimen of the kind. This form of sarcoma was called by Wedl "a fibrous form of cancer arising from bone," and should undoubtedly include the cases hitherto described as examples of scirrhus of bone. Mr. Wilkes, of Salisbury, has recorded a case of the kind in a man of fifty, who had a globular mass below the middle of the horizontal ramus of the jaw, adherent to the bone, but movable, and after removal of one-half of the jaw the tumor was found to be inclosed in a thick fibrous capsule connected with the periosteum. A similar growth of the size of a chestnut, with a cavity in the centre, was removed by Mr. Coates from a man of sixty-seven, and both specimens are now in the Hunterian Museum.

5. *Fibro-sarcoma* closely resembles fibroma in external appearance, and generally grows beneath the periosteum. A tumor of the upper jaw in the

Museum of University College, London, is of this nature, springing from the antrum and projecting through its anterior wall, and also through the hard palate.

6. *Chondro-sarcoma*, in which spindle-celled or round-celled sarcoma is mixed with the cartilage which forms the bulk of the tumor, occurs in both jaws, and frequently leads to secondary deposits in the lungs. I have elsewhere[1] recorded the case of a woman, aged forty-four, from whom I removed a large piece of the lower jaw with an enchondromatous tumor of large size, the patient being discharged from hospital twenty-one days after, with the wound quite healed, and with no signs of recurrence. Eleven weeks after being discharged, she was readmitted with a recurrence of disease on both sides of the gap in the lower jaw, and a second operation was performed; but it was found impossible to remove the whole of the growth, which had spread into the pterygoid region. A large, fungating mass formed and protruded externally, and the patient sank on the forty-third day after the second operation. At the autopsy, the mass of growth extended from the zygoma downwards for over seven inches, and was from five to six inches in thickness. Another tumor sprang from the right segment of the divided jaw, and the left side of the tongue and floor of the mouth were largely invaded. The upper jaw was not involved, but only imbedded in the growth, which had forced itself deeply among the neighboring parts, where the veins were filled with firm white clots, though no growth had sprung up in connection with their walls. The tumor on section varied in color, being yellowish-white in some parts, whilst it was red and vascular in others, and mottled with patches of extravasated blood. It weighed two pounds and three ounces. There were two nodules of secondary growth in the left lung, and three larger ones in the right lung. One of these was distinctly seen to be lying in the course of a good-sized branch of the pulmonary artery, whose walls were expanded over it. It did not completely block the lumen of the vessel, and on its surface was a white fibrous deposit.

The mass removed at the first operation consisted chiefly of enchondroma with dim hyaline and fibrous matrix, but interspersed were islets of round-celled sarcoma. The recurrent masses were made up chiefly of round-celled and spindle-celled sarcoma, whilst scattered throughout were isolated portions of cartilaginous tissue with fibrous matrix.

7. The names *osteo-sarcoma* and *osteoid chondro-sarcoma* imply the occurrence of ossification in tumors containing sarcomatous elements, and include the cases hitherto described as "osteoid cancer." A good specimen of the kind is preserved in the Hunterian Museum, and is figured in Howship's "Surgical Observations." The preparation has been macerated, and the part which remains consists of an oval mass of light, cancellous bone, about five inches in its chief diameter, and very slightly connected with the remaining bones of the face. At its lowest part, it preserves somewhat of the form of the alveolar border of the upper jaw; and the incisor, canine, and bicuspid teeth are implanted in it. The frontal bone shows evidence of a secondary growth from within it. The patient was a woman of thirty, and had had the tumor, which is described as "fleshy," for five years, dying from hemorrhage consequent upon extraction of a tooth.

A good example of ossifying sarcoma in the lower jaw, has recently been under my care, in a man of fifty, from whom, in May, 1881, I removed a portion of the horizontal ramus of the lower jaw, cutting well beyond a fleshy tumor which involved it, and which had been growing some months. A recurrence took place, and I disarticulated the jaw on the affected side in October of the same year. Shortly after, the disease reappeared on the central portion of the jaw, and I removed a further portion, going beyond the median line, in January, 1882, but was unable to remove the whole of the disease, which had by this time extensively involved the soft tissues of the cheek. The patient died exhausted in April, 1882. In this case the specimens showed ossification taking place in the sarcomatous tissue, and the fungating mass which formed before death would doubtless have developed a complete skeleton similar to that in Howship's case, had the patient's strength held out sufficiently long.

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[1] Lancet, November 24, 1877.

CARCINOMA.—The only form of *carcinoma* affecting the jaws is epithelioma, which is found in at least two varieties, the squamous and the tubular. The position of these depends upon the nature of the normal epithelium of the part: thus the squamous epithelioma is developed primarily in the mucous membrane of the palate and gums, the normal epithelium of which is squamous; whilst the tubular form, with cylindrical epithelium, begins in the antrum or nose, the epithelium of both of which is columnar. Both forms of epithelioma have a great tendency to invade surrounding parts, especially the bones, and hence the difficulty of completely extirpating the disease, except by proceedings of a magnitude which may not be justifiable in the weak condition of the patient.

Squamous epithelioma of the palate and gums begins very insidiously, and its nature is therefore often mistaken at first. Commencing as a small, ragged ulcer on the mucous membrane of the gum, it is often, and probably correctly, attributed to the irritation of decayed teeth or fangs, or to secondary syphilis, but is regarded as of little importance, or is, perhaps, aggravated by the application of nitrate of silver or other irritants. Ulceration of the palate of an epitheliomatous character is more frequently attributed to tertiary syphilis, and even large gaps in the hard palate, caused by epithelioma, are supposed to be the result of a broken-down gumma. But epithelioma of the gums or palate never, I believe, occurs before the age of forty, and more often nearer sixty than fifty, whereas the secondary manifestations of syphilis take place, as a rule, earlier in life, and the tertiary symptoms are much less urgent than those of epithelioma.

By involving the subjacent bone, necrosis is induced in the course of an epithelioma, and here again error may arise if the presence of bare bone be regarded as pathognomonic of necrosis, without considering the cause. Loosening of the teeth is a natural consequence of the invasion of the alveolus, and affords a fair criterion as to the extent of the mischief in the deeper parts. Creeping up the sockets of the teeth of the upper jaw, squamous epithelioma tends to invade the antrum secondarily, and without giving rise to any marked symptoms of antral disease. This form has been described by Reclus[1] under the title of *epithéliome térébrant* (boring or burrowing epithelioma), and Mr. Butlin[2] has described a case of the kind in a man, aged sixty-two. I do not agree with that gentleman, however, in regarding the disease as extremely rare, for I have had at least three cases recently under my care, in which the gums and palate were primarily affected, but in which the antrum was found to be extensively involved when it was opened up.

The treatment of squamous epithelioma of the jaws, as of that in other parts of the body, consists in prompt and free removal of the affected part. When the disease is confined to the gum and margin of the alveolus, comparatively mild proceedings may be justifiable in the first instance; but if the disease has gone at all deeply, removal of the upper, or of a large portion of the lower jaw, should be undertaken without hesitation. Even then it may be impossible to clear away the whole of the disease, which, as in Mr. Butlin's case, may "extend through the lower wall of the orbit to the eyes, into the spheno-maxillary fossa, and up between the temporal and masseter muscles and beneath the temporal aponeurosis." Mr. Lawson[1] has advocated, after removal of the jaw, the use of caustic paste, and the destruction of the skin covering epitheliomatous growths of the antrum, as being the most efficient mode of treatment, and I believe with good ground; but the drawback is of course the terrible deformity resulting, which to many persons would be worse than the disease.

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[1] Progrès Médical. 1876.

[2] Pathological Transactions. 1881.

The *tubular form of epithelioma* may originate in the antrum, or, commencing in the nose, may secondarily invade the antrum. The growth is characterized by great rapidity of development, and softness, and the surrounding structures are apt to be rapidly involved. Hence tumors of this class were formerly considered as examples of soft cancer. When beginning on the nasal mucous membrane, the stoppage of the nostril is generally the first symptom noticed, and possibly temporary relief may be obtained by the removal of the so-called polypi. When the disease begins in the antrum, it leads to a rapid expansion of the cheek, with stretching and thinning of the skin, which eventually becomes involved, and ulcerates, giving exit to a fetid, watery discharge, and permitting the formation of a yellow, fungous growth. The nose and the orbit become secondarily involved, and the growth is apt to find its way into the several fossæ of the outside of the skull.

In the treatment of this form of disease, the remarks already made on the treatment of squamous epithelioma apply with double force. But the question often arises, when it is obviously impossible to hope for such a complete removal as shall insure future immunity from relapse, whether any operation may be undertaken with the view of giving relief and prolonging life. I have no hesitation in recommending an operation undertaken with these objects, in suitable cases, because I have found that I have been able to give enormous relief, both bodily and mental, to patients with incurable tumors of the jaw, by getting rid of the mass of the disease, which, by its size and unsightly appearance, was a daily burden; and have prolonged life for some months, in comparative comfort, by giving space in which the fresh formation could lodge itself without interfering with deglutition or respiration, and without causing the sufferer to be an eyesore to himself as well as to others.

OPERATIONS ON THE JAWS.

In all operations upon the jaws, the greatest care should be taken to avoid extensive scarring of the face, and the infliction of unnecessary deformity, particularly by breaking the line of the lower jaw. Incisions for the relief of inflammation or the evacuation of matter, and punctures for emptying cysts or the antrum, should invariably be made within the mouth. Extraction of sequestra may be performed in most cases more conveniently through the mouth than by external incision, though the surgeon may occasionally avail himself of existing sinuses. The removal of epulis in all its varieties can be readily accomplished through the mouth, if the operator is provided with proper bone-forceps of various kinds, and even large portions of the jaws may thus be removed with success. The late Mr. Maunder,[2] on two occasions, removed large portions of the right side of the lower jaw with the surrounding tumor, without any external incision, separating the soft parts with a raspatory, and sawing the bone in front of and behind the tumor. The principal difficulty in these operations was not so much the separation of the tumor, as its "delivery" through the mouth, which was slightly split in one instance. Fortunately the hemorrhage in both cases was slight, and the patients did well, but another surgeon was less fortunate, and lost his patient by secondary hemorrhage; and considering the close proximity of the facial artery, and the necessary division of the inferior dental artery, this is not to be wondered at. For my own part, I do not think that the extra trouble and risk of the proceeding are balanced by the absence of a scar, which in the majority of cases need not involve the lip, and, if properly placed, will be nearly invisible afterwards. The same may be said of the so-called "sub-periosteal resections" of the upper and lower jaws. In cases of necrosis, it is of course advisable to preserve all the periosteum, and in extracting a sequestrum, it may be occasionally necessary to turn aside the soft parts with a raspatory; but any systematic stripping of periosteum from a jaw involved in a tumor, is not only impossible in most instances, but, if undertaken, will only leave shreds of periosteum with possibly some portions of diseased tissue attached. In one case in which I took considerable trouble to preserve the muco-periosteum of the palate, when removing the upper jaw, the flap proved a great annoyance to the patient during convalescence.

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[1] Clinical Society's Transactions. 1873.

[2] Med. Times and Gazette, July, 1874.

REMOVAL OF THE UPPER JAW.—Partial or complete removal of the upper jaw may be most conveniently performed as follows, the incisions being extended as the gravity of the case may indicate. A straight incision through the median line of the upper lip, and prolonged on one side of the columna nasi into the nostril of the affected side, will allow the tissues of the face to be readily dissected up from the jaw, so as to expose completely the front wall of the antrum. This may then be perforated and removed with bone-forceps, so as to permit of the extraction of a tumor from within, or room may thus be found for the removal of large portions of the palate.

In a case of more extensive disease, in addition to the incision already made, one should be begun near the inner angle of the orbit, and be carried down by the side of the nose and around the ala into the nostril. This will allow of further reflection of the soft tissues, and more complete exposure of the bone, so that it would be easy to cut away large portions of the jaw with suitable bone-forceps; or a small saw could be readily carried transversely from the nostril at any desirable level, so as to preserve either the palatine or orbital plate.

For removal of the entire upper jaw, it will be advisable to make an additional incision below the orbit from the inner angle to the malar bone, following the natural curve of the skin-markings of the part. This incision may be prolonged on to the malar bone as far as may be necessary, and may be met at its extremity by another at right angles to it in very extensive disease of that bone. The flap of skin is now to be reflected outwards, and this method has the great advantage of preserving the facial nerve, and of dividing only small branches of the facial artery.

Division of the bone will be required at three points: (1) the palate, (2) the nasal process of the maxilla, and (3) the malar bone; and these sections may be made with the saw or bone-forceps, or more conveniently with both. A narrow saw, with movable back, is to be passed into the nostril, and the hard palate divided with the alveolus, from which a central incisor tooth should have been previously extracted. The saw should be kept parallel to the floor of the nostril, and there need be no fear of damaging the pharynx with its extremity. The movable back allows the blade of the saw to pass through the bone into the mouth, thus dividing the whole of the hard palate without the splintering which usually follows division with bone-forceps. The soft palate escapes injury from the saw, and any attempt to dissect off and preserve the soft covering of the hard palate is futile. The nasal process of the maxilla may be conveniently notched or completely divided with a small saw, and the saw is next to be applied to the malar bone, parallel to and immediately in front of the masseter muscle. This cut will then run into the spheno-maxillary fissure, and the prominence of the cheek will be preserved; but in cases of very extensive involvement of the malar bone, it will be necessary to remove the whole of it by dividing the zygomatic process, and the frontal process at its junction with the frontal bone.

Before dislocating the bone, it is well to divide the soft palate transversely, close to its attachment to the hard palate, which can be readily done from the mouth. With a pair of angular bone-forceps, the three cuts made with the saw should then be thoroughly cleared, and it is convenient to take them in the reverse order, viz., malar bone, nasal process, palate. The bone-forceps, when dividing the palatine attachments, may be conveniently used to tilt the whole jaw forward, and the lion-forceps should then be employed to grasp it, and forcibly depress the mass, while the scalpel is used to divide the infra-orbital nerve behind the bone so as to prevent its being stretched, and also any soft tissues which may remain attached to the jaw. The hemorrhage, which is often sharp for the moment, is best checked temporarily by thrusting a sponge into the opening, and this after a few minutes' pause may be withdrawn, in order to allow of the application of the actual cautery at a black heat, so as to sear any bleeding vessel. A careful examination should be made to see that all the diseased tissue is removed, when caustic paste may be advantageously applied to any doubtful parts; after which the flap of skin is to be replaced and fixed with fine wire sutures, and with harelip pins for the lip, the red margins of which are best approximated by a fine silk stitch. Unless the oozing of blood is so considerable as to necessitate plugging the wound, it is, I am sure, better not to introduce any lint beneath the cheek, since it only collects discharge and becomes very offensive in a few hours, when its withdrawal is both difficult and painful. Thorough sponging with a strong solution of chloride of zinc (forty grains to the ounce), and subsequent dusting with iodoform, will keep the parts sweet for some days, after which free syringing with antiseptic lotions is useful, and for this purpose nothing answers better than the continuous stream of the siphon nasal douche.

Removal of both upper jaws has been performed a few times, and in very severe operations of the kind recourse may be had to Trendelenburg's method of performing tracheotomy and plugging the trachea by an India-rubber tampon around the tracheal tube. This instrument is somewhat unsatisfactory, however, for if blown up sufficiently to really plug the trachea, it is apt to produce urgent dyspnœa by pressure on the rings of that tube; and a more satisfactory method will be found to consist in performing tracheotomy, and then plugging the upper part of the pharynx with a sponge, to which a string is attached for safety's sake.

Dr. Goodwillie, of New York, and other surgeons, have employed the "dental engine" in operating upon the upper jaw, and profess to have found their operations greatly facilitated by the use of this machine. There can be no question that great rapidity may be gained in the use of various drills and saws ingeniously adapted to the engine, but experience is wanting, in England, at least, in its use, and the great rapidity of its action would appear to be not unaccompanied by danger.

Removal of the Lower Jaw.—In removing portions of the lower jaw, the incision should as far as possible be placed below its border, so that the cicatrix may be hidden. An incision from the median line to the angle, thus placed, will divide the facial artery immediately in front of the masseter muscle, and both ends should be at once secured with a ligature. The tissue of the face can now be dissected up, and the cavity of the mouth opened by dividing the mucous membrane close to the gums, when any part of the body of the jaw can be removed by making a section with the saw on each side of it. In making these sections, it is better not to complete one before the other is begun, because of the loss of resistance consequent upon breaking the continuity of the bone; but each cut, being carried nearly through the bone with the saw, may be conveniently finished with the bone forceps. Should it be necessary to prolong the incision beyond the median line, and to remove the symphysis, care must be taken to guard against the falling back of the tongue by having a stout thread passed through it, upon which traction may be made. The mylo-hyoid muscle and mucous membrane inside the bone can then be divided, and the piece removed, but whenever possible the alveolus alone should be divided and the border of the jaw preserved. In removal of one-half of the lower jaw, it will be advisable to divide the lower lip in the median line; for though it is possible to perform the operation without this, yet if the disease is at all serious, it unnecessarily complicates the operation to save the lip, which reunites readily enough. The incision should then be carried at right angles to that in the lip, along the lower border of the bone as far as the angle, and then upwards to near the lobule of the ear. This will necessarily divide the facial artery, but no important branches of the facial nerve, unless prolonged into the parotid gland. The tissues of the face and the masseter being dissected up from the bone or tumor, the jaw is to be divided at a convenient point, a tooth having been previously extracted. The scalpel is then to be carried closely along the inner surface of the jaw, to divide the tissues forming the floor of the mouth, and care must be taken not to detach or damage the sub-lingual gland. The cut end of the jaw, being grasped with the lion-forceps, can now be everted so as to bring the internal pterygoid muscle into view, and this must be dissected from the bone. Should the disease be of a non-malignant character, and not involve the articulation, the ramus of the jaw should be sawn across in preference to disarticulating, and even when the tumor encroaches very closely upon the joint, it may be possible to divide the neck of the condyle and the coronoid process separately, with bone forceps.

In order to disarticulate the condyle, the soft tissues should be held out of the way with spatulas, when the jaw, being firmly grasped with the lion-forceps, is to be depressed so as to bring the coronoid process forward, and to allow division of the insertion of the temporal muscle. This is sometimes rendered difficult by an unusual length of the process, or by its being jammed against the malar bone by the bulk of the tumor. In this case it may be necessary to cut off the coronoid process with bone forceps, or to break it by force. The coronoid process having been cleared, the depression of the jaw from before backwards is to be continued, in order to throw the condyle forward; but great care must be taken not to rotate the jaw outwards, lest the internal maxillary artery should be stretched around the neck of the bone, and be either torn or divided, when the hemorrhage would be severe and difficult to arrest. The condyle being made prominent, the knife is to be carefully applied over it, when the bone will start forward, tearing through and bringing away with it a portion of the external pterygoid muscle. The knife must not be used to divide the muscular fibres, which bleed less if torn, but may be employed to divide the inferior dental nerve, so as to save it from being pulled out of the bony canal.

When from the nature of the tumor the leverage of the jaw is lost, and consequently disarticulation of the condyle becomes difficult, recourse may be had with great advantage to the broad spatula recommended by Professor Gross for disarticulating the condyle from the glenoid cavity. In this way the bone may be forced from its socket, and the risk of hemorrhage from the internal maxillary artery be completely avoided.

Any bleeding vessels should be secured with ligatures, when the lip should be united with harelip pins and the wound with sutures, care being taken to leave a dependent opening for the discharges.

Closure of the Jaws.

Inability to separate the jaws may be temporary or permanent. In the former case, setting aside cases of *trismus* from nervous affections, the cause is contraction of the muscles of mastication, especially the masseter, due to the irritation from an uncut wisdom-tooth. Owing to want of room between the second molar and the ramus of the jaw, or owing to some malposition of the tooth itself, the wisdom-tooth is unable to assume its normal position, and by the pressure which it exerts on the neighboring structures sets up irritation, which induces a state of tonic spasm of the masseter and internal pterygoid muscles.

The majority of these cases occur, as might be anticipated, about the age of twenty, and the diagnosis is easy, unless very great swelling, and possibly abscess, should have supervened and obscured the nature of the case. The treatment consists in administering chloroform thoroughly, so as to relieve the spasm somewhat, and allow of the introduction of a screw-gag between the teeth, in order to separate the jaws. This must be done slowly and steadily, so as not to inflict injury upon the front teeth, and the back of the jaw may then be reached. If the wisdom-tooth is presenting in its normal position, a free division of the gum over it, and removal of the flaps thus made with scissors, will be sufficient treatment; if the patient will patiently bear a little inconvenience for a time. But when there is obviously not space for the wisdom-tooth to be erupted, room must be made by extracting the second molar, unless the wisdom-tooth itself can be reached and extracted, which is seldom the case. Occasionally the extraction of the upper wisdom-tooth, against which the lower wisdom-tooth is pressing injuriously, may completely relieve the trouble. In whatever way room is given, relief is sure to follow, and in the course of a few hours the spasm of the muscle passes off.

Permanent closure of the jaws may depend upon destruction of the temporo-maxillary articulation, or more frequently upon the contraction of cicatrices in the cheek, following ulceration or sloughing. This latter condition is frequently the result of gangrenous stomatitis occurring in childhood, in which case destruction of the whole thickness of the cheek not unfrequently takes place ; but the same result may follow an attack of fever, etc., at any age. When the mischief is confined to the lining membrane of the cheek, the soft parts become firmly adherent to the alveoli of both jaws, and a rigid cicatrix of fibrous tissue, in which bone not unfrequently develops, binds the jaws firmly together. Under these circumstances the patient is often nearly starved, for he can only rub soft food between the teeth, or push it with the finger behind the teeth, on the unaffected side. In the cases where destruction of the cheek has taken place, although the deformity is more unsightly, the patient is generally able to feed better, particularly if one of the molar teeth is wanting.

The treatment of cicatrices by simple division within the mouth, is perfectly futile, for although wedges may be employed for a time to keep the jaws apart, they will certainly be drawn together by the rigid contraction of healing. In order to secure improvement in the patient's condition, it is necessary to prevent the adhesion of the cheek to the alveoli, and to restore as far as possible the pouch of mucous membrane between them. This can only be done by adapting to the teeth metal plates or shields which can be constantly worn after free division of the cicatrices, and which, reaching well beyond the gums, can prevent adhesion taking place between the cheek and the alveoli. After a long time, a formation of mucous membrane takes place in the sulcus thus formed, and the plates may then be dispensed with in the daytime, but must be worn for many months at night. It is obvious that treatment of such a protracted nature cannot be carried out in children, and that the coöperation of an able mechanical dentist is essential for success. The method is applicable only to cases in which the whole thickness of the cheek is not involved; but the extent of the adhesions is comparatively unimportant, since the plates can be adapted to both sides of the mouth, as in a case of my own.[1]

In the case of unilateral adhesions, division of the lower jaw in front of the cicatrices, and the formation of a false joint, give very good results. Esmarch removed a wedge-shaped piece of bone, so as to secure fibrous union with free mobility, while Rizzoli contented himself with dividing the jaw from the mouth, and trusted to the subsequent movements to establish a false joint. I have no experience of Rizzoli's method, but, having twice performed Esmarch's operation, have every reason to be satisfied with it. The operation is a very simple one, an incision along the lower border of the jaw easily admitting of the use of a narrow saw for the removal of a wedge of bone, the base of which should be below. The only point of importance is that the section should be made thoroughly in front of the cicatrix in the cheek, for if this is not attended to, the operation will fail. The operation is applicable mostly to cases in which one side of the mouth is affected, and in two or three weeks restores to the patient a very useful, though one-sided, amount of masticatory power, with very little suffering or annoyance. One side of the jaw remains of course permanently useless, and there is necessarily some deformity left, but the relief is permanent. A patient upon whom I operated in 1864, called on me in 1880, to show how satisfactory the movement of her jaw continued.

Inflammation of the temporo-maxillary articulation may lead to complete anchylosis of the joint, and consequent immobility of the jaws. Arthritis occurs as the result of injury, or of constitutional affection. In children it follows the exanthemata, and is often connected with suppuration in the tympanum. In adults, it is of a rheumatic or gouty, and therefore more chronic, character. Rheumatoid arthritis also affects the temporo-maxillary articulation, and leads to great suffering from the painful movement of the jaw. In two patients I have noticed the characteristic enlargement of the condyle and neck of the bone, with protrusion of the chin to the opposite side, described by Robert Adams in his great work on the subject. This disease does not, however, lead to the osseous anchylosis, or synostosis, which is met with in cases of common arthritis with suppuration.

In acute inflammation of the joint, leeching and fomentations, with timely evacuation of pus, would be the appropriate treatment. In the more chronic forms, attention to the constitutional diathesis, and the frequent application of blisters over the joint, offer the best chance of relieving the patient, but the treatment is eminently unsatisfactory. Dr. Goodwillie,[1] of New York, has ingeniously proposed to produce extension between the two surfaces of the temporo-maxillary articulation by fitting blocks upon the molar teeth, and by then drawing up and fixing the chin; and he gives several cases in which a cure was thus brought about. The anchylosis resulting from articular inflammation may be fibrous or osseous, and the diagnosis can only be made when the patient is thoroughly under the effect of an anæsthetic. Fibrous adhesions may be broken by forcibly opening the jaws, but very great subsequent care will be necessary to prevent reunion, and it may be better to perform Esmarch's operation of division of the bone in front of the angle. Dr. Goodwillie[2] has recorded two cases in which he succeeded in thus breaking adhesions with the best results.

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[1] Injuries and Diseases of the Jaws.

In cases of anchylosis of the temporo-maxillary joint, the operation of excising the condyle of the jaw has been performed in a few instances. The first removal of the condyle was by Professor Humphry,[3] of Cambridge, and was undertaken for chronic rheumatic arthritis. He exposed the condyle by a curved incision from the side of the orbit, across the zygoma to the ear, passing a little above the temporo-maxillary articulation; and by a second incision from the termination of the first, directly upward in front of the ear and across the zygoma again, avoiding the temporal artery. The flap thus made was reflected, and the neck of the condyle cut through with a narrow saw. Dr. Bottini,[4] in 1872, communicated to the Royal Academy of Medicine at Turin, the case of a lad of seventeen, who had fallen on his chin when seven years old; inability to open the mouth gradually set in, so that in a few months he was quite unable to separate the jaws. Bottini opened the mouth forcibly during anæsthesia, and inserted a wedge. This however was so troublesome to the patient that it was removed, and resection was determined on. An incision was made on one side, and the head of the jaw-bone, after the periosteum had been separated, was removed with the chisel and hammer. This had no appreciable effect, and it was only after the operation had been repeated on the other side that the jaw could be freely moved. In neither of these cases was there true synostosis, such as may be seen in a specimen of a negro's head in Guy's Hospital Museum, and such as existed in a case successfully treated by Dr. James Little,[5] of New York, in 1873. The patient was nineteen years of age, and had some years before suffered from suppuration of the temporo-maxillary articulation, leading to anchylosis. Dr. Little made an incision along the lower border of the jaw, and turned up the masseter, when the neck of the condyle was seen to be very much enlarged, and continuous with the temporal bone. A trephine half an inch in diameter was then applied, and a button of bone three-eighths of an inch in thickness was removed. The portion of bone on each side of this opening was next cut through with a chisel, and the neck of the condyle cut away piece by piece, so as to leave no portion projecting from the temporal bone. The result was quite satisfactory.

A similar operation, but performed by a different method, was successfully undertaken by Dr. Robert Abbe,[6] of New York, on a boy of ten who had suffered from otitis media and suppuration of the joint seven years before. A longitudinal incision was made in front of the ear, and a transverse one, meeting the upper end of the first, was carried along the lower border of the zygoma. The parotid and the facial nerve were drawn down, and with a periosteal elevator the posterior fibres of the masseter were cleared away, and the articulation exposed. A narrow osteotomy chisel was now applied to the neck of the condyle, and carefully driven half through the bone, when by forcibly opening the mouth the bone was broken through. The neck of the condyle was then carefully removed piecemeal, but the condyle itself was left *in situ.* The result was satisfactory. Sédillot[1] mentions that, in a case of true anchylosis of the temporo-maxillary articulation, M. Grube, in 1863, carried a straight chisel through the mouth to the neck of the jaw, which he broke by hammering. Some months later he divided the masseter subcutaneously, and the cure, by the formation of a false joint, was permanent. In 1879 I performed the same operation in a child of six, but the results were unsatisfactory. Suppuration was set up, and required an external opening, and the movement, which was free at first, became as limited as before the operation. It would appear, therefore, that mere division of the neck of the bone does not offer such good prospect of a permanent false joint as removal of the neck or the condyle, though these operations are necessarily more severe.

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[1] Archives of Medicine, vol. v. June 3, 1881.

[2] Monthly Review of Dental Surgery, October, 1875.

[3] Association Medical Journal, 1856.

[4] British Medical Journal, August 31, 1872.

[5] Transactions of New York State Medical Society. 1874.

[6] New York Medical Journal, April, 1880.

Esmarch's operation, performed in front of the masseter, is of course as applicable to cases of anchylosis from disease of the joint as to cases of cicatrix, and Fischer[2] appears to have performed the operation on both sides of the jaw, in a case of bilateral anchylosis of the temporo-maxillary articulation, with very good result, the patient obtaining complete and useful control over the central, movable portion of the jaw.

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[1] Médecine opératoire, tome ii. p. 30.

[2] British Medical Journal, June 1, 1872.

SURGERY OF THE TEETH AND ADJACENT PARTS.

BY

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Dentistry, although a specialty of surgery, has become almost a distinct science—distinct in the fact that it may be taught independently, and also in the fact that heretofore many of its most skilful practitioners have reached the highest excellence without any knowledge of general surgery. Nevertheless, it is a department of the great science and art of medicine, and its highest possible attainments must have the more comprehensive science for their foundation.

Its best results have been due so much to the dexterous manipulative ability of its practitioners, that the general surgeon has regarded it as a mechanical trade, and has ignored it in the acquirement of his education.

The science of dentistry is medical, surgical, and prothetic. Dental therapeutics includes a class of operations which are not taught in the medical schools, and are not practised in the offices of physicians and surgeons, but the successful performance of which requires special appliances, special surroundings, and mechanical and æsthetic qualities of a high order; hence, by universal consent, these operations have been assigned to a special class of practitioners, who, by limiting their range of action, have perfected themselves in their chosen sphere of work. Every operation of oral surgery requires a delicacy and precision of touch which is rarely found in the practice of general surgery. There is no preparatory training which the general surgeon could add to his other necessary acquirements, to perfect himself in the dexterous use of instruments, at all comparable to a mastery of the operations in dentistry.

Surgery of the Deciduous Teeth.

Lancing the Gums.—Surgical interference is frequently demanded even before a tooth is erupted in infancy. Localized stomatitis may be relieved in many cases by *lancing the gums*, an operation, however, which is not always indicated, and which has undoubtedly been many times resorted to injudiciously. If the tooth or teeth suspected to be the cause of local irritation, as well as of constitutional disturbance, are not far advanced and ready to erupt, lancing the gums may do more harm than good, the incision perhaps closing with cicatricial tissue, which may cause subsequently greater disturbance than if no incision had been made. "When tumefaction of the gum is dependent on tooth eruption, and the child is of healthy condition, a certain evidence is found in the glistening character of the swelling, the part immediately over the tooth or teeth looking stretched and feverish. This tense look is nearly always present, and may, under all circumstances, be esteemed an indication demanding the lancet." Lancing in such cases, if properly performed, yields almost instantaneous and complete relief.

The incision should be made with reference to the shape of the tooth ; thus, for any of the anterior teeth, either above or below, the cut should be made on a line with the cutting edge of the tooth, and deep enough to strike the enamel. For the canine teeth and those posterior to them, the crucial incision is better, making the lines diagonal to the jaw rather than parallel or at right angles with it. Undue hemorrhage need not be apprehended. The loss of a little blood is ordinarily rather to be desired than otherwise.

Extraction of Deciduous Teeth.—The mere removal of a temporary tooth when dentition is proceeding regularly, and the period has arrived for it to be shed, is an operation of minor character. In normal dentition, the waste of roots and surrounding processes goes on relatively and simultaneously with the advance of permanent successors, and, without interference, the temporary crown will literally be shed from the gum ; but abnormal second dentition is of such frequent occurrence, together with diseases which attack the crowns and roots, that extraction in advance of shedding is often demanded.

If there be no disease, such as a painful pulp exposed by caries, or an ulceration or abscess following such exposure, it is unwise to remove a temporary tooth, unless its permanent successor is emerging from the gum beyond the boundary line of the dental arch. The normal order is to follow and succeed to the exact position occupied by the temporary tooth. The abnormal is an emergence from the gum, either within or without the arch, while the temporary tooth is still in place. As soon as such abnormality is discovered, extraction of the deciduous tooth should be immediate. The extraction of deciduous teeth that have remained firm in the jaw after the period of shedding has been reached without any evidence of the emergence of their successors, is not indicated. Sometimes a permanent tooth never erupts, and the sacrifice of a deciduous tooth which has occupied its position is an irrecoverable loss.

It is very common for there to be a want of development or increase in the size of the jaw, commensurate with the demand for more room which the growth of large permanent teeth, to occupy the place of their small predecessors, demands. The result is an apparent necessity for removing two temporary teeth to make room for one permanent tooth. This is frequently the case as the six front teeth in either jaw are erupting, and whenever the difficulty has been met by extracting two teeth to make room for one, it has almost inevitably created a crowding out of line, and an irregularity in the permanent dental arch. Only in very rare and exceptional cases should such a procedure be adopted, and it is especially desirable that each of the canine teeth should be retained until the certainty of the eruption of its successor has been assured.

When it becomes necessary to extract the deciduous molars long in advance of their period of shedding, care should be taken that the alveolar process be not grasped in the forceps, lest the germ or partly-developed crown of the permanent tooth should be included and removed, which would be an irreparable injury. The premature extraction of temporary teeth has been strenuously opposed by some, because it has been believed that contraction or shrinkage of the jaw would follow; but this view has been found to be fallacious, because the maxillæ develop quite independently of the teeth. The teeth, it will be remembered, grow upon, not out of, the jawbone, and the alveolar processes form and increase about the roots of the advancing teeth. Alveolar processes grow up with the teeth, and are absorbed and waste away when the teeth are gone. The maxillæ, during the process, develop up to the type of their inheritance, irrespective of the changes in the alveolar processes.

SURGERY OF THE PERMANENT TEETH.

EXTRACTION OF PERMANENT TEETH.—The removal of a tooth is rarely a difficult operation, when its anatomy and that of its surroundings are apprehended; but there is no operation in dentistry which requires more firmness, self-control, and confidence in one's own ability. A timid, nervous, unstable hand will be almost certain to do damage, sometimes almost irreparable.

The roots seldom penetrate the true maxilla to any extent, and the surrounding walls of alveolar process are so vascular, elastic, or frail, that they give way more rapidly than might be supposed. Nevertheless, there are exceptional cases which tax the utmost ingenuity and strength of the operator to manage. The most difficult teeth to extract are ordinarily the cuspidati of either jaw, and the first two molars of the upper jaw. The difficulty with the canines is owing to their extremely long roots, and with the molars to their having three roots each, which generally diverge from the crown so that the diameter of the socket at the neck of the tooth is less than the extreme breadth at the apices of the roots. It is indeed a wonder, sometimes, that they ever come away without tearing the alveolar process along with them. The teeth which are removed most readily are the lower incisors, and after them but little difference is seen in the extraction of the upper incisors and the bicuspids of both upper and lower jaws. All of these last named have, substantially, but one nearly straight root, and all are of about the same length. The first two molars of the lower jaw, each with two roots, are more readily removed than the corresponding teeth of the upper jaw, while the third molars above and below are taken out with comparatively little strength.

The propriety of the removal of teeth must be determined entirely by the judgment of the operator. In the present advanced state of dental skill, the absolute necessity for the extraction of a tooth ought to be very rare. As patients avail themselves of the benefits of dental science, so will the extraction of teeth which are firm in the jaw become more and more infrequent.

Experience has shown that the simplest and best instrument for extraction is the forceps. Formerly the turnkey was the sole instrument employed, but the principle of its application is so ill-adapted to the end required, that any directions for its use are unnecessary. It is a dangerous instrument to use in almost all cases, and has been superseded by such as are admirably adapted to their purpose. The specialist may have, with some slight advantage, a peculiar forceps adapted to each tooth in the mouth, and the variety of these forms is now such that each different kind of tooth may have its special forceps; but for the general surgeon such an array of instruments is quite unnecessary.

Dr. Hasbrouck, of New York, who has for sixteen years made a specialty of extracting teeth with the aid of anæsthesia induced by the administration of nitrous-oxide gas, finds that he can extract all the teeth of both upper and under jaws with but two pairs of forceps. With a forceps of bayonet-shape, with straight handles, and with beaks alike of medium width, every tooth of the upper jaw can be removed; and what is called the "universal lower-molar forceps" may be used for all the teeth of the lower jaw, provided that the blades or beaks are not too wide. An additional set of two pairs may be added with advantage, viz., one nearly straight, and one curved almost to a right angle, both with quite narrow beaks; these are more appropriate to the small teeth above and below than the instruments first described. Any number more than these will be absolutely required only to suit the fancy of the operator, or to meet some extraordinay occasion.

In extracting any of the upper teeth, the best position is with the head of the patient against the left breast of the operator, who places his left arm around the head, and clasps it by putting his fingers in the mouth and against the upper jaw. For the lower jaw the operator should stand behind, with the patient's head against his stomach; thus, with his left hand holding the chin and his thumb in the mouth, the jaw is held firm while extracting. Many authors lay much stress upon lancing the gum previous to the application of the forceps, but in the experience of those who have the largest practice in this specialty, lancing is rarely required. Forceps as now made have thin edges, and in using them should always be firmly forced up the surface of the tooth until they reach the alveolar process; this act will drive away the gum and render lancing unnecessary. No special directions can be given for the manner in which a tooth should be drawn, except that luxation or rotation may be of a little advantage with teeth that have single roots; but rotation with the molars is impossible. The strength required and the direction of movement must be left to the judgment of the operator, as he feels the necessity at the moment.

Sometimes it is impossible to extract an upper molar without resorting to an intentional removal of the buccal wall of the alveolar process, but this should only be a last resort. If, in the effort to extract any tooth that has a living pulp (particularly a molar), it should be broken off, the immediate results may be serious. An upper molar with strong surrounding walls, broken in this way, may be almost impossible of removal, and the fractured and exposed pulp will cause violent pain. The best immediate treatment will be the use of the actual cautery, if it can be applied; otherwise, a minute quantity of arsenious acid upon a small pledget of cotton, dipped in oil of cloves, will give relief.

The removal of small portions of the process accidentally, is not uncommon, and serious results need not be apprehended. That which has come away would be absorbed within a short time if it had been left. Neither is there to be any danger anticipated from prolonged hemorrhage.

Hemorrhage for a few minutes is to be expected, but if profuse and prolonged, a plug of lint with tannin placed in the socket, and a compress to hold it, will soon stop the bleeding.

Sound teeth should never be extracted to make way for artificial ones. One, two, or three sound teeth which are firm in the jaw, will be worth more for mastication than all the artificial substitutes that can be employed.

IRREGULARITIES OF THE TEETH.—With advancing civilization there is an apparent increase of deformities of the dental arch. In the higher social scale, it is exceptional to find a young person with a perfectly developed and regular row of teeth set in a well-formed and rounded arch. More commonly, departures from this type will be found of every grade, more or less pronounced, exhibiting some of the phases of narrowed jaws, with teeth protruding, overlapping, and crowded in every conceivable state of disorder. In many instances, the cause has some direct connection with other evils that seem inseparable from a state of high civilization.

A close observer for a generation has seen a multitude of cases which had no apparent local cause, were not of hereditary origin, and could only be attributed to constitutional conditions developed in the individual. As a general statement, the finer the nervous organization—the more precocious, or brilliant, the intellect—the greater will be the tendency to dental deformity.

The converse is true of feeble-minded people who, having a fair physique, show well-rounded jaws and regular dental arches.

Many peculiarities are of inherited origin as far as the individual is concerned, but what may have caused the initial departure from a normal type in preceding generations, it is impossible to determine. More readily, perhaps, than any other deformities of the human organization, are dental irregularities transmissible, and departures from a normal type in the parents reappear in the children in an exaggerated form.

Irregularities that require treatment are never seen in the deciduous teeth. The deciduous dental arch is always well formed and symmetrical. It is only in the second set that deformities make their appearance; and it is exceptional that such peculiarities can be foreseen and prevented. It cannot be determined with any certainty, before eruption, that a dental arch is going to be abnormal, the causes being generally hidden and remote.

The normal type of the dental arch describes a regular line; the arch may be wider or narrower, varying somewhat in individuals or races, but the line will be an easy, graceful curve, without break or tendency to form an angle. Within certain limits, a narrow dental arch, as associated with certain features, may become the perfection of beauty; while with another form of head and face, the widest development may be equally pleasing. That which is recognized now as the standard or full measure of beauty, as well as of utility, is not unlike that which existed in the remotest historic ages, nor different from that which is now exhibited among all communities not degenerated by luxury or vice.

Abnormalities include such a shape of the arch as is not in harmony with the surrounding features, all crowding and twisting of the teeth, and all departures from a regular line in their positions. One form of irregularity seems to be due to unwise or premature extraction of the deciduous canines of the upper jaw. In the ordinary course of nature, these teeth should be the last to drop out. If extracted long anterior to their period of shedding, the permanent bicuspids are liable to encroach upon the domain of the canines, and thus deprive them of their place in the arch. Such a malposition can be foreseen and prevented. Another abnormality of the superior dental arch which can be prevented is the result of thumb-sucking, or its equivalent, in the earlier years of childhood. The effect of this habit is to protrude all the teeth in the front part of the mouth. This deformity will not show itself until the eruption of the permanent teeth, sometimes even after the practice which caused it may have ceased.[1] But a large proportion of dental irregularities cannot be predetermined with certainty, even where there is an hereditary tendency, and can be corrected only when they develop. An observer with limited experience may often be misled by the appearance of teeth as they first erupt. They may seem to be growing out of the line of the arch, and it may be thought that a permanent irregularity is inevitable. But many such cases need no interference; if left to themselves the teeth will acquire regularity, and will often assume their true places unless the occlusion of the antagonizing teeth prevents them.

But interference is demanded as soon after eruption as it becomes certain that a deformity is inevitable. There is then no longer justification for delay, for after that period every year increases the difficulties, both pathological and mechanical, and prejudices the stability of the dental apparatus. But all irregularities in the position of the teeth are not deformities which demand treatment; there are many departures from a normal type where neither the utility nor the beauty of these organs, nor the symmetry of surrounding features, is seriously affected by the malposition. The regulation of teeth, moreover, often involves the wearing of fixtures which cannot be removed and cleansed as frequently as the health of the mouth demands; their continued presence may provoke caries of the teeth; and prolonged treatment may seriously injure the nervous system; wherefore the regulation of teeth should not be undertaken without due consideration.

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[1] In one instance which came under the author's observation, a mother of good social position had nursed from her breast a daughter until the latter was nine years old, the result being that the girl's six upper front teeth were protruding so that her lips could not be closed.

Regulation of teeth may be undertaken, under favorable circumstances, at any age short of full maturity; but, all things considered, the most desirable period to begin the correction of an extensive irregularity, is when the cuspidati and second molars are fully erupted. The occlusion of the teeth is an important factor in determining the permanency of the change. All attemps at correction, at any age, will be futile, unless the antagonizing teeth, upon occlusion, will serve to hold the displaced teeth in their new positions. Success in treatment is based upon the fact that the teeth are placed upon the maxillæ, surrounded by vascular, elastic, bony processes, which are easily moved or absorbed under pressure, and that reproduction of bone will follow, and will make the teeth solid in their new locations. The possibilities under favorable conditions, within certain limits, are almost unbounded. Narrow jaws may be widened, protruding jaws made to recede, individual teeth moved considerable distances, and teeth elongated or shortened, or twisted in their sockets. The success of skilful efforts in this direction has been triumphant.

Some of the most marked cases are where the face is deformed by a protruding or receding jaw, either upper or lower. Strictly speaking, when this occurs with the upper jaw, it is not the maxilla which is at fault, but rather the whole dental arch. Such a condition in the lower jaw is more likely to arise from a defective articulation at the joint, but in either case, when taken at the proper age, it is quite amenable to treatment. It is not always advisable to attempt to alter the form and expression of a mouth where the condition is an inherited peculiarity—a part of the family type—and where the change would involve prolonged effort, with possible breaking up of a good articulation of masticating organs, and with the knowledge that nature will be constantly making an effort to return to the hereditary type. In hereditary cases of extensive deformity, in which interference has been delayed until at or near maturity, we can never feel certain but that the original tendency to malposition, so long unbroken, may reassert itself at any time that we abandon the use of retaining fixtures.

Upon general principles it is desirable to retain every sound tooth in the mouth, yet there are many cases of crowded dentition where the removal of a tooth upon each side of the jaw is justifiable. The retention of every tooth in the mouth is not necessary to the efficiency of the masticating apparatus, and is not required to maintain the contour of the jaw, while the loss of certain teeth produces no visible external effect.

The articulation of masticating organs is of more importance than their number, and a limited number of grinding teeth, fitting closely upon occlusion, will be of greater benefit to the individual than a mouth full of teeth with their articulation disturbed.

The treatment of irregularities is almost entirely mechanical. To the anatomical, physiological, and pathological knowledge required of the operator, there must be added a knowledge of mechanical science, and the ingenuity to apply it. Levers, pulleys, inclined planes, wedges, and elastics, singly and in combination, are required for this purpose. It is quite impossible for any one to overcome a complicated dental irregularity, who has not a comprehension of each and all of these instrumentalities.

As far as pressure itself is concerned, it is immaterial from whence it is derived. The same weight, force, or power will produce the same result. It is only a matter of convenience what source shall be employed. For widening a narrowed arch, a jackscrew is the most effective means, and can be used to spread one tooth only, or all the teeth upon both sides according as it is applied. Wedges driven between the teeth will enlarge the arch. Levers, with elastics, are used to twist teeth in their sockets, and an inclined plane can be made to move teeth laterally. The application of such apparatus to effect the movement of teeth, is one of the most responsible duties the dentist is called upon to perform. Each and every one of these mechanical powers can be made to do his bidding, and equally each one of them may become a formidable engine of disaster. When applied to the mouth, they should have constant watchfulness and care. Not one of them but, in the hands of an empiric, may cause the destruction of those valuable organs which, when skilfully used, they can be made to conserve.

Dental Caries.—Caries of the teeth depends on a constitutional condition which originates in an impairment of function, either in the individual or in his ancestors; consequently, on a condition which is common among highly civilized, and correspondingly rare among savage races. Civilization bears the same relation to caries of the teeth, that it does to other diseases which are incidental to, and the outgrowth of, a violation of hygienic laws. In a strong and healthy organization, where there is no inherited predisposition to caries shown in a defective organic structure, teeth will not decay excepting from want of nutrition arising from functional disturbance.

Like any other tissue of the body, the teeth require constant nutrition, or they will yield to external agents; but unlike other tissues, repair will not follow the return of nutrition. Excepting for defective nutrition, teeth of good organization, in a healthy body, will remain sound for a lifetime without care; while teeth with an inherited frail organization, and easily liable to decay, may resist for a lifetime adverse influences, by the aid of constant supervision and attention to bodily health.

Microscopic investigation shows that the organic matter of a tooth forms a reticular network, which traverses the entire structure, dentine, cementum, and enamel inclusive. It forms the matrix of the lime salts, and is the vehicle for the nourishment of the organism. Caries is a solution of the lime salts, originating always from outside influences favored by a congenitally frail organization, or by an acquired state of diverted or impaired nutrition.

External agents of an acid character are the sole local cause of decay, and by far the greater part of this decalcification is caused by acids produced in the mouth by fermentation—lactic, acetic, butyric, etc. All electrical conditions found associated with decay, as well as the presence of bacteria, micrococci, or leptothrix, do not constitute causes, but are incidental results.

Micro-organisms are always present in carious dentine, but it is very doubtful if they have the ability to penetrate beyond the layer of tissue softened by acids. In healthy conditions the saliva is alkaline, while the secretions of the mucous membrane are acid; but the teeth do not suffer from this acidity, because it is neutralized by the saliva, whereas in an unhealthy condition the mucous secretions may be in excess, or the saliva may become acid. Food in its fermentative stages, between the teeth, may contribute to this state. Starchy foods are found to give decided acidity, while animal food gives an alkaline or neutral reaction. The vulnerable points are found in fissures of the enamel in defectively formed teeth, which permit the entrance of decomposing agents. In well-formed teeth, caries is most likely to begin upon the adjoining surfaces, where food has lodged and fermentation ensued. Caries in the beginning is almost always circumscribed and local, its progress being along the line of the dentinal tubuli, in the direction of the pulp, and more rapid in the dentine than in the enamel, because of its higher organization.

The teeth most liable to decay are the bicuspids and molars, upon their adjoining surfaces; and those least liable are the six front teeth upon the lower jaw, with the canines of the upper jaw.

There is another manifestation of caries, differing from that already described, which fortunately is not very common, but which is equally disastrous in its results and more difficult to combat. It shows itself in a general wasting of the buccal or labial surfaces of the teeth, sometimes forming great horizontal grooves near the gum, with clean polished surfaces, and with no trace of decomposed dentine.

The usual treatment of circumscribed caries is here seldom applicable. The cause appears to be systemic, and the wasting can only be arrested by a change in the general tone of the system; local and topical remedies are of little avail.

Treatment of Caries.—This is almost exclusively surgical and mechanical; medical remedies, independent of other treatment, are of little value. In some exceptional cases of shallow, superficial decay, if the affected part be removed with proper instruments, until sound dentine is reached, and if the new surface be polished, decay will not again set in. But probably in not one case in a thousand treated in this way, can caries be prevented from reappearing. As a general statement, there is only one course now known which can be regarded as effectual, viz., to cut out the affected part and replace it with some indestructible material which will close the orifice of the cavity absolutely.

The choice of the material to be used is of secondary importance. Anything which will be permanent and fluid-tight will meet the conditions, but some substances which have been used are much better suited to the purpose than others.

Gold, tin, amalgam, gutta-percha, and plastic materials, such as the oxychloride and oxyphosphate of zinc, are in common use. None of these substances, unless possibly the above-named plastic articles, possess any medicinal power upon tooth structure; the benefits derived from their use are purely mechanical—their office is solely to make a tight plug.

Gold in the form of foil or crystals has proven to be, in accessible cavities with strong walls, the best material. It will make a filling against which no objection can be urged, except its color, and even in that respect it harmonizes better with tooth-structure than any of the other materials named. Some of the efforts of operators in gold have been marvels of skill; by the aggregation of small particles, welded together as the work proceeds, whole crowns of teeth have been built up of pure gold. The discovery of the cohesive property of gold is due to dentistry. But for a large class of cases gold is not applicable, and if used may prove to be the worst material. For large cavities, its introduction involves great expenditure of time and force, to condense the filling properly, and consequently great danger of injuring frail walls. In the hands of injudicious though skilful manipulators, gold has frequently been productive of more harm than good. Frail walls have been weakened and shattered, and sooner or later disintegration of tooth-structure has ensued and the tooth been sacrificed. To some of the methods of using gold is attributable much of the damage that has occurred. After the discovery that gold could be welded under pressure, the mallet came into general use for condensing the mass, and each particle of gold was hammered into solidity as it was introduced; automatic mallets, electric mallets, and mallets run by machinery were introduced, but by whatever force the mallet was propelled, there is no doubt of the injury which it caused, unless used with exceeding caution. A mallet is really unnecessary to the perfection of any filling.

The only advantage that *tin* has over gold, is that it is cheaper and can be introduced with less skill, but it is not as durable as gold, because in time it becomes completely oxidized.

Amalgam is now used under various names to disguise the fact that mercury forms one of its principal ingredients. Its composition is of silver and tin, about equal parts, alloyed and made into filings. These filings are softened and amalgamated with mercury, which gives the mass the property of setting or crystallizing in a short time, and becoming a piece of dense, solid metal.

A very small percentage of gold or platinum, or of both, is sometimes added, and the mixture is called "gold and platinum alloy;" but the addition of these metals does not give the composition any appreciable quality, and by whatever name it may be called, it is simply an amalgam. Very exhaustive experiments have been made within a few years, and all the resources of science have been brought to bear, to improve this filling material, until, as now made, it has all the good qualities that are ever likely to be obtained. The best article will not tarnish in the mouth, and will not shrink, and, excepting its color, seems to be as near a perfect metallic filling as is likely to be found. Although the color is a steel-gray, which it will retain, it is not a color that harmonizes as well with tooth-substance as that of gold, and is not as well adapted for fillings which are exposed to sight. The great advantage of amalgam is the readiness and certainty with which it can be used, and its indestructibility. No tooth has ever been made weaker by its introduction. At certain periods much prejudice has existed against the use of amalgam for a filling, because it contains mercury, but the observations of all unbiased practitioners, together with the most critical tests which can be made, show that this prejudice is groundless.

Gutta-percha is one of the best substances for filling teeth that has ever been discovered. The preparation employed is made by bleaching the gum, and adding a small percentage of mineral substance, thoroughly incorporated. For very large cavities upon the adjoining surfaces of the teeth, which reach under the gum, it has no equal. It is tolerated by the gum in contact with it as no other material is. It is not difficult of introduction, will not weaken a tooth in its application, and is insoluble. The objection to it is that it will not bear the abrasion to which a filling upon the grinding surfaces is subjected. Nevertheless, it is probable that if *every* filling which has heretofore been made of gold had been made of gutta-percha instead, more teeth would have been permanently saved.

Two other preparations in common use are worthy of mention: the so-called "oxychloride of zinc" and "oxyphosphate of zinc." They are prepared by first roasting the oxide of zinc of commerce, grinding, and then mixing, for one with muriate of zinc, and for the other with phosphoric acid. The zinc, being in a fine powder, when mixed forms a paste which sets almost instantly, and which makes a very hard substance, only soluble in the fluids of the mouth to a moderate extent. These are valuable preparations, particularly the "oxyphosphate" which seems to exert a medicinal influence upon the pulp of a tooth and upon supersensitive dentine. For fillings in children's teeth, it seems to be well adapted. It is also of especial value in large cavities near exposed pulp, where it may nearly fill the cavity and be finished out with gold.

The *preparation of a cavity for filling* requires delicate manipulation, in removing the decay, and in shaping the cavity so as to assist in the retention of the filling. All that portion about the orifice which is decayed must be removed until sound structure is reached.

It is prudent to remove all softened dentine from the cavity, if it can be done without exposing the pulp, but it is very imprudent and unnecessary to remove all the softened dentine from the bottom of the cavity, if in so doing pulp-exposure is liable to occur. If any decay be permitted to remain, it should be treated antiseptically before the filling is introduced, and recalcification of that portion may be expected. When caries has advanced to the stage in which the pulp is irritated or inflamed, grave difficulties may be encountered. It is not yet settled what is the best treatment to pursue in all cases.

The earlier practitioners made no attempt to save a tooth after the pulp had become exposed. It was sacrificed to the forceps. This plan has been followed for a generation by that of destroying the pulp, removing it, and filling the vacancy even to the apex of the roots. The destruction of the pulp is brought about, in almost all cases, by the application of arsenious acid. The usual course is to make a paste of the arsenic with sulphate of morphia and a little creasote; a minute quantity, less in bulk than a small pin's head, is sufficient to devitalize a pulp; if, however, after two or three days, sensation still remain, the application may be repeated. At as early a date as possible after sensation ceases, the pulp should be removed. Small Swiss broaches which have been barbed, will enable the operator to do this in most cases of single-root teeth, but with the molars it is doubtful if every shred from each root is always removed. After as thorough a removal as possible, the remains, if any, should be treated with creasote, and the cavities immediately filled. Occasionally an operator may be found who will extirpate a pulp without the previous application of arsenic, but the treatment, while sanctioned by sound philosophy, is too heroic to be put into general practice. Within a few years, an outcry has been made against the devitalization of pulps, even after exposure; or, if pulpitis has occurred, the practice of attempting to restore them to health and usefulness is advocated. The method is to remove with much care all extraneous matter from contact with the pulp, and cap it in such a way that the superincumbent filling will not impinge upon it. A favorite plan is to make a thin paste of oxyphosphate of zinc, gently bring it in contact, and allow it to set, before the filling of the main cavity is undertaken. But the results have been far from generally successful, and it is still doubtful if it be the better practice in most cases to attempt to retain the pulp alive.

Before the introduction of any filling, the cavity should be made perfectly dry, and kept so during the entire operation. This can be done by taking a piece of bandage-rubber, punching a small hole in it, and slipping it over the tooth. Another important result is obtained by using this sheet-rubber even before the excavation of the cavity is begun. Softened dentine is hypersensitive; in sound dentine there is rarely any painful sensation from cutting, but decalcified dentine seems to be in a state of inflammation, and is easily irritated; by using the rubber-dam, as before intimated, the cavity of decay can be made dry by absorbents and by a jet of warm air; the complete drying of the irritable dentine destroys its sensibility. This is found to be the most successful method of obtunding the sensitiveness of dentine, as almost every other means fails. Occasionally, an application of some escharotic appears to act beneficially, but long experience has shown these to be so unreliable that there is little use in resorting to them. Dentine is usually most sensitive when it borders upon the enamel, and least so in larger cavities as decay approaches the pulp. Free access to cavities is necessary to insure success in filling them, and hence, if cavities occur upon adjoining surfaces of teeth which are in close contact, space must be made. Filing teeth for such a purpose is almost always unjustifiable. Space can be made by wedging. Wood, cotton, or rubber may be used for wedges, and in a few days sufficient space will be gained for operating. The teeth will resume their positions after the wedge is removed.

TOOTHACHE.—This arises more frequently from an exposed pulp than from any other cause. The next most frequent source of toothache is in the investing membrane of the root. This second form rarely, if ever, occurs while the pulp is living and healthy; in fact, inflammation of this membrane seems never to occur until after the pulp, for some cause or other, has died.

Toothache may arise also from other more hidden and less tangible causes. Ossification of the pulp, exostosis of the root, and the formation of so-called pulp-stones, are not uncommon sources of pain. Pain may be localized in a tooth which is quite sound, and the cause may be discovered to exist in some diseased tooth far removed from the aching member. Temporary pain may follow the eating of certain fruits or sweets, which come into contact with sensitive dentine through some minute crevice in the enamel; this is a common occurrence, in apparently sound teeth, and such pain does not always indicate that the affected tooth is decayed or requires filling. Aching teeth are sometimes only a symptom of systemic disturbance, and the cause must then be looked for elsewhere. Pulpitis and pericementitis are, however, the chief causes of this disease. Exposed pulps that have not taken on an active state of inflammation may be relieved of pain by the application of oil of cloves, creasote, oil of peppermint, laudanum, chloroform, tincture of aconite, phosphoric acid, and possibly many other remedies, any of which may be applied to the exposed pulp by saturating a small bit of lint, and gently placing it in the cavity of decay.

None of these have a tendency to immediately destroy the pulp. If devitalization is desired, a minute quantity of arsenious acid may be used with either of the foregoing as a menstruum. Toothache may sometimes be relieved by the external use of a lotion composed of equal parts of chloroform, laudanum, and tincture of aconite, applied on the cheek against the tooth, but particularly using it immediately behind the ear of the same side of the head. A last resource is extraction, which, except in very rare cases, is not justifiable. In many cases, neuralgia of the head and face is owing to dental irritation. Cavities of the teeth which do not reach the pulp, receding gums which expose roots too near their apices, and the encroachment of tartar under the gums, are among its fruitful causes.

"Any portion of the head, throat, or associate parts supplied by the fifth nerve, or indeed by its related nerves, may be the seat of reflex trouble from a dead pulp—thus we have odonto-gastralgia, odonto-cephalalgia, odonto-cardialgia, etc.; even sciatica has been cured by the extraction of a diseased tooth." Pain arising from exostosis cannot be diagnosed with certainty, but when it becomes evident that that is its cause, extraction is the only remedy known. Pericementitis, as before stated, only follows death of the pulp. In the earlier stages of inflammation, an application to the gum of a mixture of tincture of iodine and tincture of aconite, over the seat of pain, may afford relief; or the gum may be stippled with saturated tincture of iodine, thus establishing minute blisters. This failing, resort should be had to leeching, which, if done before suppuration has set in, will produce the desired result, but, if suppuration has begun, will be likely to aggravate the evil. If the suppurative stage has been reached, and the pain continues, poulticing or lancing is indicated.

Alveolar Abscess.—In many cases of abscess at the roots of the single teeth, the pus may be reached without lancing, by passing a fine broach through the nerve canal. This is not difficult with the six front teeth, and is preferable to making an opening through the gum, unless the pus have already made its way through the alveolus. Alveolar abscesses are often difficult to cure, particularly when there are no fistulous openings, and when they have been of long standing. Opening into them through the canals of the roots, and treating them with antiseptics, is the usual course, but it is a common experience that this cure is but temporary. Latterly iodoform has been used in these cases, and it is claimed with perfect success. Oftentimes a chronic alveolar abscess can only be cured by heroic treatment, viz., making an opening through the gum and alveolus, cutting away the ulcerating sac at the root, and cutting and scraping away the devitalized bone in the immediate vicinity. Then cleansing the cavity with tepid water, to which a little salt has been added, a complete cure will be pretty certain to follow.

Cystic tumors of the jaw are of two kinds, simple and compound. The first show only expansion of the bone with varying fluid or gaseous contents, beginning as slightly flattened enlargements on the side of either upper or lower jaw, and slowly increasing until they reach the size of half a hickory-nut, but seldom larger. They are tardy in growth, unaccompanied by pain, and local in their origin, their occurrence being evidently attributable to dental irritation. The gum covering them always appears normal, without congestion, inflammation, or anything to indicate its implication in the disease. Their course is chronic and benign in character.

In some cases, pressure upon such a tumor will produce a parchment-like, crackling sound, but this is by no means general, as the outer wall, in many instances, will be found upon examination to be supported by a spongy growth or septa of bone, too firm to yield under any ordinary external pressure. The term "spina ventosa" has been applied to these cases. Treatment of such a cyst is not difficult. A crucial incision should be made through the body of the tumor, and such septa as exist should be broken up. No anxiety need be felt concerning hemorrhage. The cavity should be syringed with salt and water, or other slightly stimulating liquid, and stuffed with lint saturated with tincture of iodine. This will cause the base to throw out granulations, and the cure will be complete.

Dentigerous cysts are compound in their character, showing in addition to the contents of a simple cyst, elements of a dental nature, and owing their origin usually to an impacted or otherwise undeveloped tooth which lies imbedded in the jaw. Every impacted tooth, however, does not lead to the formation of a cyst. The cause of this condition appears to be: first, misplacement or diversion of a tooth-germ, so that in its growth it will not emerge from the gum; and secondly, the accumulation of serous fluid within the dental capsule, which thereby becomes distended, and, increasing in size, involves the surrounding tissues. Generally the crowns of teeth connected with dentigerous cysts are found to be normal, but their fangs are more or less abortive and defective.

A cyst may also arise from an unerupted supernumerary tooth. The latter can generally be recognized by its position and size, being seldom larger than an ordinary pea, and mostly situated in the palatine process of the maxilla. An exploring needle will readily determine its presence, if used by one who is familiar with the touch of tooth-substance. Dentigerous cysts sometimes assume a most formidable character, containing as their germ abnormal masses of dentine and enamel, unrecognizable as belonging to any particular tooth—the distinguishing feature of a dentigerous cyst being simply the presence of dental tissue in some form or other.

These cysts may occur in any part of the maxilla, and their cause and character may be inferred from the absence in the arch of a tooth which is undeveloped. The cases are very rare in which a deciduous tooth becomes encysted. The teeth most frequently found in this condition are the superior cuspidati, and next in frequency the third molars; but a cyst may form about the crown of any impacted and unerupted tooth. The treatment of these cases is substantially the same as that indicated for a simple cyst—opening, evacuating the contents, and removing the imbedded tooth-substance, which is likely to be found opposite to or furthest from the thinnest part of the expanded wall. Such portions of the bone should be removed as may seem necessary, and the cavity should be treated with tincture of iodine. All cutting should, if possible, be done within the mouth.

Prothetic Dentistry.

This is a far more appropriate term to apply to the art of replacement than the designation of "mechanical dentistry" which this branch usually receives, since, strictly speaking, more than 90 per cent. of all the operations performed in dentistry are purely mechanical. The filling of every tooth cavity, with no matter what material, belongs to the art of replacement, and is as much a mechanical performance as the construction and insertion of artificial teeth. The term "mechanical dentistry" is unfortunate, too, inasmuch as it implies that the requirements for its practice are not above the level of ordinary mechanics, whereas the greatest achievements of prothetic dentistry demand artistic tastes and abilities far beyond those of mere mechanism.

Considering the universality of the need, the whole range of medical science affords no greater boon than that which replaces by art lost organs, and thus enables the functions of the human economy to go on uninterrupted. The truth of this proposition can only be realized by imagining all the artificial teeth now worn to be suddenly destroyed, and the art of making them forever lost.

Artificial teeth of a century since were generally carved out of ivory; porcelain teeth were then unknown. When a full denture was required, the teeth and the base which connected them were carved from a single block; and, as works of art, in imitation of nature, some of these dentures have never been excelled. Another plan of that epoch was to carve a base or plate to fit the gums, and upon that to mount the crowns of natural teeth which had been obtained from other sources. Experience soon demonstrated that ivory was subject to the same influences, when used in the mouth, as the natural teeth, and that it became offensive and useless from deterioration and decay. In the early part of the present century, gold and silver plates were substituted for ivory, still using natural crowns for teeth, but as these also in a short time decayed and became useless, porcelain crowns were introduced. The first teeth of this material were made by the French, but were exceedingly rude and unsightly; very shortly after, that is, about 1830, American dentists began their manufacture, and to day the art is carried to almost absolute perfection, and the American manufacturer now supplies almost the entire demand throughout the world.

These teeth are composed of quartz, feldspar, and clay, in proportions of about five parts of spar, two of quartz, and less than one of clay, ground into an almost impalpable powder, mixed into a plastic mass, and moulded or carved into form. Platinum pins are inserted, to facilitate their ultimate attachment to the plates. Teeth and gums are made of the same material, the difference in coloring being due to enamels. These moulded forms are subjected to a heat of more than 2000° F., to vitrify them and develop their colors.

There are four chief varieties of artificial denture, according to the principle upon which they are inserted and sustained, viz: (1) Pivot-teeth; (2) Plates with clasps; (3) Plates sustained by atmospheric pressure; and (4) Plates of simple adaptation.

A PIVOT-TOOTH is a single artificial crown, secured by a pivot to a natural root, and only applicable where the crown of a tooth is gone, and where a sound and healthy root, to which the artificial crown can be attached, remains in the jaw. The use of pivot-teeth is of very ancient date, going back to classic times, and possibly earlier. A generation since they fell into disuse, but within a few years have been revived, and, under a score of different names, but applying the same principle, are now extensively inserted. Where roots are sound and in a perfectly healthy condition, the adaptation of pivot-teeth is, when skilfully executed, without exception the most convenient and most useful for the patient. Formerly the tooth was simply fitted to the root, which was cut off close to the gum, and secured by a pivot of wood, generally of condensed hickory. This plan fell into disuse, because the junction was never so perfect but that the fluids of the mouth would act upon the root, causing decay and loosening the pivot, when in a short time the crown would become useless. At the present day, there is one plan which is entitled above all others to a claim of superiority. It is to fit a thin, narrow band, or ferule, accurately around the stump, and to push it just under the edge of the gum, and to this ferule to attach the artificial crown by soldering. The ferule protects the joint and prevents decay. Additional strength is also given to the crown by screwing it to the root. Another variation of much value is to make the entire crown of gold, hollow like a shell, and fitted to and over a stump. This method is not applicable to the front part of the mouth, because the crowns have the appearance of solid gold, but for the bicuspids and molars it is a very valuable form of restoration. Still another variation of this plan may be used sometimes with excellent results when two or three teeth are missing. In such cases two crowns are secured to the roots, as above described, but they are also connected with each other by a bridge or bar, to which are attached the other missing teeth. Thus two sound roots may be made to support the crowns of several others. The advantages of pivot-teeth are cleanliness, security, utility, and the absence of any covering to the natural gums.

PLATES WITH CLASPS are applicable to either jaw, when there are two or more remaining teeth separated from each other and firm in their sockets. This is the best plan (where plates, as a base upon which to set the teeth, must be used) that can be devised, wherever admissible. The plate which bears the artificial teeth is sustained by clasping to the natural ones. Objections have been made against clasped plates, that the teeth are injured which sustain them, but this objection loses all its force when the work is skilfully executed. It is only bungling and ill-fitting clasps and plates that do the damage. The advantages are that greater security is given than with other forms of plates, and that a less surface of the gum is covered.

PLATES HELD BY ATMOSPHERIC PRESSURE are the last resort for an upper denture when all the natural teeth are gone. There is then no other plan which can be resorted to which is not more objectionable, and therefore unnecessary to notice. With atmospheric-pressure plates the whole of the roof of the mouth must be covered, even to the posterior border of the palatine bone. The application of the plate is secured by raising its central part from contact with the roof, and creating a defined chamber of from one-half to three-fourths of a square inch of surface. If the plate were accurately adapted, and if all the air could be exhausted from such a chamber, thus creating a perfect vacuum, a pressure of from eight to ten pounds would be obtained, and the plate would sustain such a weight before it would drop; but practically no such security is ever reached. The adaptation is faulty, and, consequently, the most that is ever attempted or expected, is to get stability sufficient to bear the tipping strain of mastication. In practice this can usually be obtained, and in mouths where the mucous membrane is thin and hard over the bones and processes, such an amount of adhesion can be secured without difficulty; but where the gums are thick and spongy, exuding more or less viscid, mucous fluid, real suction is almost impossible. The retention of plates under such conditions is due not as much to atmospheric pressure as to simple adhesion.

Full dentures for the lower jaw are retained only by the accuracy of their adaptation, and by their own weight. Ordinarily they are far more troublesome for a patient to manage than those for the upper jaw. The muscles of the tongue and cheeks are continually lifting them out of place, and sometimes no amount of weight will keep them quiet. As a general rule, it will be found that the older patients are, the more intolerant they are of weight. So that while younger patients will tolerate and be benefited by all the weight that can be obtained, old patients must have as little weight as possible. It is because of the want of stability of all full lower dentures, that it is particularly ill-advised to remove all the teeth from the lower jaw, even when only one remains, if it is firm enough to give steadiness to the artificial denture. The retention of one tooth, anywhere upon the lower jaw, is of untold value in adding to the comfort of the patient.

The requirements of dental prothesis are frequently more than a mere restoration of masticating apparatus. With the loss of the alveolar processes, comes an entire change in the external form of the face and in its expression. A restoration of expression involves artistic study and ability, and the bases upon which the teeth are set often have to be built into peculiar shapes to produce such results. In some cases, plumpers as large as filberts are needed to fill out the sunken cheeks. There is no loss of alveolar processes or adjoining maxillæ, however extensive, consistent with the life of the patient, that may not now be measurably restored by mechanical skill. Large portions of either or both jaws have been carried away by gunshot, and the comfort of the patient and his masticating ability restored by nicely adjusted prothetic appliances.

The *bases* upon which artificial teeth are set are of two sorts—metallic and plastic—each with its advantages and disadvantages. Platinum, gold, silver, tin, aluminum, and some compositions, of which tin forms the main part, have been found useful. Vulcanized rubber and celluloid are the two chief plastic substances which have been used for the same purpose. Each one of these materials finds its place and its advocates, but they are not all equally desirable, in regard to either durability, comfort, cleanliness, or health. Gold and platinum rank first, because of their strength and purity. They are not acted upon by the fluids of the mouth, and a strong, delicate, and artistic piece of workmanship can be made from them. With very little care, a set of teeth thus made can be kept clean, sweet, and free from odor. The objections to gold or platinum lie only in cases of full upper sets, generally for elderly persons, where long teeth have to be added, which, together with an artificial gum, make a set of great weight, and liable to overcome the suction-power by which it is held in place. Excessive weight is an objection in upper sets, but has no disadvantage in lower ones, except for very old people. Therefore the material which might be the best for a lower set might be the worst for an upper one.

In nearly all cases, save those named above, gold or platinum is much the best, for either partial or full upper dentures.

Silver possesses some of the advantages of gold or platinum, and is much cheaper. The objection to it is that it is not as strong, not as durable, and not as easily kept clean. It discolors readily, and in time is eaten up by the acid secretions of the mouth. Aluminum is rarely used. It possesses an advantage over other materials in being the lightest of all known metals, but there has not been sufficient experience with it in dentistry to justify its general use. Tin is a very valuable metal as a base for teeth, especially for full lower sets. It is a pure metal, not easily oxidized, readily worked, and quite durable. For a lower set, where economy is necessary, it has advantages over any other material. It is strong, readily repaired, and can be kept clean without difficulty. Since the discovery of vulcanite, or hard rubber, it has been extensively used as a base for artificial teeth. Its popularity has come from the ease with which an unskilful dentist can put together a useful set of teeth upon it, and its consequent cheapness. Its advantages lie in the readiness with which a fit can be obtained, and (when not too clumsy or bungling) in its being lighter than any metal, and thus admirably adapted to make sets for the upper jaw. The objections to it are that it is brittle, and, except when great thickness is used, wanting in strength, and continually liable to break down; that it is impossible to repair it and make it as good as new; that, being a non-conductor, it has a constant tendency to inflame the gums, making them soft and spongy; and that it is almost impossible to keep it sweet and clean. The advantage which its lightness gives it for an upper set makes it equally objectionable in most cases for a lower one.

Recently, celluloid has become a rival of vulcanite. Celluloid is a combination of cellulose and camphor, and is of about the same strength, elasticity, and durability as vulcanite, and as easily worked. The only advantage which it thus far seems to possess over vulcanite is in its translucency and color, which is a close imitation of that of the natural gum; but this is offset again by the fact that in a little time it loses its color and has a dirty look. It is open to the same objection as vulcanite, in the difficulty of keeping it clean.

Artificial teeth require more care than they commonly receive, and so does the mouth while they are being worn. The idea that as soon as the natural teeth are gone and replaced by artificial ones, all care is at an end, is a fallacious one. More care is required to keep them sweet, and the gums healthy, than the natural teeth would have demanded from the same person. They ought not to be worn night and day. Any suction plate, whether full or partial, will injure the roof of the mouth, sooner or later, if constantly worn. No appliances can be worn in air-tight contact with any part of the human organization continuously, for months and years, without producing injurious absorption. In the mouth, the gums become inflamed, spongy, and diseased, as the result of such contact. This state of things is aggravated by want of cleanliness on the part of the patient.

Simply rinsing off a set of teeth does not make them clean. Particles of food will accumulate upon the plate, and in the crevices, and within a few hours will ferment and make the set foul, and nothing but a liberal scrubbing with a brush, and often with some alkaline wash, will sweeten it. With small plates, clasped to adjoining teeth, constant care is needed to keep the inside of the clasps absolutely clean, and also the natural teeth which the clasps surround, or the teeth will rapidly decay. The plates which are least liable to do injury to the gums, are those of gold and platinum, and those which are most injurious are of vulcanite. There are three objections to vulcanite plates, viz.: the character of the material, the poor workmanship usually employed in making them, and the lack of care which is taken of them. The first objection is inherent and unavoidable; the second shows itself in all cheap work, the surface which comes in contact with the gum being left rough and unfinished; and this makes it more difficult to cleanse the plates properly. On retiring at night, all artificial teeth with plates should be removed from the mouth and thoroughly brushed with soap and water, and afterwards scrubbed with pulverized chalk. They may then be placed in a glass of water, to which a little common soda has been added, and left until needed in the morning. Teeth should also be removed and brushed after each meal, if the wearer desires to meet his associates without a foul breath. If the gums are inclined to be spongy, the ball of the thumb should be wet with tincture of myrrh, and all the spongy surface rubbed daily until it becomes harder.

By this process the suction-power which keeps an upper plate in place will be increased. Artificial teeth will not last a lifetime. The average period during which they are worn without renewal is but a few years. This results from several causes: the perishable nature of the materials used; ordinary wear and tear; liability to accidents; but more than all, the constant shrinkage of the gum, which goes on to some extent as long as life lasts, and on account of which the plate loses its adaptation and usefulness.

Methods of making Artificial Teeth.—An impression of the space desired to be filled is taken in some plastic material. Plaster of Paris, gutta-percha, beeswax, and some composition of beeswax and various gums, are the materials commonly used. The last three are prepared by heating until they become sufficiently plastic to receive an imprint without disturbing the soft tissues. Plaster of Paris is the most reliable substance for the purpose. The best method of preparation is to take the desired quantity of water, and to drop gently into it all the plaster that the water will take up. Beat it well together by stirring, thus freeing it from all air-bubbles, and it is ready for use. If it is desirable to have it set very quickly, add a teaspoonful of salt to each pint of the water used. Good plaster mixed in this way will set in about sixty seconds.

An impression made of plaster of Paris shows the most minute details of structure. Wash the impression with a lather of soap, rinse it off, and pour other plaster into it; an accurate model of the parts is thus obtained. When metallic plates are required, such a model is duplicated by moulding in sand, and casting zinc, thus making a die; the counter-die is made of lead, and between these the plates are swaged with a heavy hammer.

A plate thus made should fit the mouth or parts required accurately. The teeth are attached by the platinum pins which were baked into them at the time that they were made, and are connected with the base by linings and solder. A set of artificial teeth mounted skilfully on gold, will show all the artistic finish of a piece of fine jewelry, besides being so nicely adjusted to its place that it can be worn with entire comfort.

The highest order of mechanical and artistic talent is capable of development and display in making prothetic apparatus of this kind. The use of vulcanite or celluloid involves but little exercise of the same abilities. The method used for those substances is quite different. No dies are required, but, instead, the teeth are arranged upon the plaster model; they are kept in position by a base of sheet-wax, and wax is also used to build up the form of the denture desired. This form is inclosed in a flask and surrounded with plaster, after which the wax is removed and its place filled with rubber which is prepared for the purpose. The rubber is vulcanized at about 320° Fahr., for one hour, and thus becomes a permanently durable substance.

Celluloid is treated in much the same manner, excepting that it is not vulcanized, but is forced into the shape of the mould under great pressure, at about the same temperature.

Vulcanite has been an inestimable boon to thousands of impecunious edentulous people, but it has been a curse to "dentistry as a fine art."

Mechanical Treatment of Lesions of the Palate.

Lesions of the palate are either congenital or acquired. With a loss of any portion of the palate, whether congenital or accidental, sufficient to make a permanent communication between the buccal and nasal cavities, the perfect articulation of any spoken language is impossible.

The chief evil arising from congenital cleft palate which demands the interference of science and art, is the defective articulate speech. The effect upon the speech varies much with different individuals. It does not seem to depend upon the shape or the extent of the fissure, or upon the intellectual status of the patient, as much as upon some other influences which are not easily determined. No physiologist, however large his experience, can tell with certainty, by simple observation of such a fissure, all the articulate sounds which will be defective.

The peculiarities of speech shown by persons with cleft palate, form a very interesting study. In most cases which have come to my knowledge, the sounds of K and G have been wanting, but I have seen other cases of intelligent and fairly educated people, with whom every consonant sound of the English language has been defective excepting those of K and G.

Aside from the inability to articulate, the resonating tone-power of both buccal and nasal cavities becomes entirely changed by their partial or complete union, or by the change in their form or dimensions, so that the speech of a person with cleft palate becomes altered in tone, indistinct in enunciation, difficult and sometimes impossible to understand, and altogether disagreeable. To such an extent has this condition operated on sensitive minds, that it has, in the absence of relief, sometimes driven the sufferers from society, and made them utterly wretched.

Such an affliction is sufficient to call forth all the resources of science in producing a remedy. The only thought which has seemed to govern surgeons in adopting the operation of staphyloraphy, has been that a roof to the mouth of natural tissue must be better *per se* than no roof, or than an artificial one, but although the operation has been tested in a thousand cases by the most eminent surgeons of their time, it has resulted in such an uniformity of failure, considered as a beneficent operation, that it should, in my judgment, have been long ago abandoned. Without a complete understanding of the physiology and function of the velum and pharynx, it would be a natural supposition, that, as there are evils arising from a fissured palate, if the cleft could be closed, the evils would pass away; but a better knowledge of these functions in the mechanism of speech, shows that it is impossible to correct such defects by surgery, and a lifetime of experience has demonstrated the correctness of this statement.

The *velum palati*, as an organ of speech, is second to no other in importance. It is hinged like a valve to the edge of the palatine bone, while its posterior border may be elevated or depressed by the action of muscles. It can be raised until it comes into close contact with the walls of the pharynx, and thus shuts off all passage through the nares, or it can be depressed until, meeting the dorsum of the tongue, the passage through the mouth is stopped; or, again, it may hang midway between the oral and the nasal cavities, and thus sounds emitted from the larynx may pass through both mouth and nose.

But for the performance of these functions the velum must be free from perforation or fissure, and must be of such length that when elevated it will meet the pharyngeal wall. If a natural velum without a cleft has not this requirement, it cannot perform fully the function of articulation. It would interfere as much with perfect articulate speech as if it were fissured, perforated, or in any other way defective. Articulate speech is dependent in its perfection not only upon the integrity of the velum, but also upon the activity of the pharyngeal muscles. The closing of the posterior nares is due equally to the elevation of the velum palati and to a simultaneous advancement of the pharyngeal wall. This function of the constrictor muscles of the pharynx is seldom recognized. The pharynx is an important organ of speech in normal articulation, and in the effort to articulate with abnormal organs it develops an activity and a power at times truly wonderful. Indeed, in some instances the superior constrictor of the pharynx, in conjunction with the tongue, has, in cases of absence of the palate, enabled the patient to make many sounds which in normal articulation are dependent upon the integrity of the latter. The failure of surgery has not been in its inability to bring the edges of the divided velum together, and to get union, but it has been in the fact, before pointed out, that the newly formed palate which results from staphyloraphy is always too short, that its posterior edge does not and cannot be made to reach the pharynx, and that the speech will necessarily be defective, in spite of the operation, save in some extraordinary cases. As an operation, it is with justifiable pride that the surgeon may view the result of his work in seeing a complete union throughout the entire length of the fissure, including the uvula, and apparently a normal septum where before was a gaping orifice; and thus he may lose sight of, first, the fact that this new palate has very little muscular power as compared with the normal organ, owing to the injury which its muscles have received in the operation, and, second, that it is defective in dimensions, because there never was tissue enough to make a velum which would bridge the chasm in both its breadth and length.

The origin of the fissure is in lack of a development of sufficient material to come together and make a perfect septum, and no division of the muscles or stretching of the tissues subsequently will make up for developmental deficiency. A successful operation, surgically considered, has often been not only valueless but productive of positive harm. The new velum becomes a rigid curtain which splits the column of sound in its upward ascent, and renders it less manageable even than it was before. In early life a patient with cleft palate acquires a certain control over his voice, and a measure of articulation which a non-elastic and immovable curtain deprives him of.

As operative surgery fails, prothetic surgery comes to the rescue. Where nature is deficient she may be supplemented by art, and an organ whose function has been destroyed by accident, disease, or want of development, can have that function restored by properly adapted apparatus. The restoration of speech to a person who has once possessed that faculty, and who has lost it through a destruction of the palate, is comparatively easy; but to confer the faculty of perfect speech with an artificial organ upon one who has been afflicted from birth with the absence of the natural organ, and has grown to maturity without the ability of distinct utterance, is a much more difficult problem. In acquired lesions, even crude appliances, made without much skill or accuracy, are often beneficial; while in congenital cases the full resources of science and the nicest adaptations of art are needed to accomplish the desired result. The partial destruction of any organ of speech may occur after the acquirement of speech, and nature makes an extraordinary effort to overcome the difficulty by increased use and activity of other organs which in a measure supply the deficiency. Thus, total loss of speech will follow the destruction of the hard palate, but instant restoration will result upon the introduction of proper apparatus. But in a congenital case the faculty of perfect speech must be acquired by practice, even after the introduction of the most skilfully constructed and scientific appliance.

APPARATUS FOR CONGENITAL DEFECTS may be of two sorts. First, the gap may be filled with an elastic, movable appliance, so constructed that it will grasp the remnant of the velum upon each side of the fissure, and be lifted or depressed by the movement of the adjacent muscles. Such an instrument must be made long enough to reach the pharyngeal wall when that wall is advanced by the action of the constrictors. The elevation of the artificial palate by the levatores palati, together with the advance of the pharyngeal wall, as before indicated, will form a conjunction which will permit the perfect articulation of oral sounds, while the nasal sounds will be heard when the muscles are relaxed and the voice passes by the nares. The second form of apparatus for congenital cases depends for its usefulness entirely upon the activity and control of the constrictors. It is non-elastic and immovable, the part occupying the cleft is made bulbous, and with this bulb the pharyngeal wall comes into contact during constriction.

The first form is applicable to all congenital clefts. The second may be used where the superior constrictors are well developed and active.

The objections to the first form are that the movable part, being made of elastic rubber, must be renewed from time to time, and that the patient is not quite as independent as with the more durable, non-elastic apparatus. The objections to the latter are that it is not always as certain that the wearer will learn to articulate with it as with the elastic instrument, which more nearly fulfils the function of the natural organ in movement. With neither kind will perfect articulation follow immediately, but must be acquired by persistent and thoughtful application and practice.

The benefit to be derived from the use of an artificial palate depends upon the intellectual status, the application, and the perseverance of the patient. The responsibility for the result rests solely with the patient, after the appliance best adapted for the purpose has been introduced. Results cannot be guaranteed. All that can be said is, that appliances can be made which can be worn with freedom from discomfort, and that a large number of persons have made such use of them as to completely hide in their speech any evidence of their deformity.

The improvement is sometimes rapid and remarkable, in other cases slow and tedious—showing in the latter a want of application, an insensibility to the defect, and a dulness of capacity on the part of the patient. The result must be accomplished by the same character of attention and training as would be given by an adult to the mastery of a foreign language, or of a musical instrument.

There is no limit to the age during which such instruments may be introduced, but as bad habits or peculiarities of speech become more and more fixed and incurable the older one grows, even with normal organs, it is more encouraging to begin at the earliest age practicable. But little will be gained, however, by introducing such apparatus into the mouths of mere children, before they are of an age to realize its importance and to coöperate with the efforts made in their behalf. As a general rule, it is quite as well to await the eruption of the twelfth-year-old molars, after which period there is but very slight enlargement of the jaws, or increase in the size of the fissure.

Acquired lesions of the palate are corrected by mechanism far more readily and with much greater certainty than are the congenital. The effect upon speech of any perforation of the palate which permits abnormal escape of sound to the nasal cavity, is disastrous, but the remedy comes instantaneously when the proper apparatus is introduced. Appliances for congenital cleft tax the utmost ingenuity of the maker, but the requirements for acquired lesions may be of very simple character. Anything which can be worn over or in the orifice, which will interrupt the passage, will restore the faculty of speech; so that the instrument may be made of any of the materials used as a base for artificial teeth, and requires to be but a cover or stopper to the opening, nicely adjusted, and secured generally to some adjacent teeth. In all lesions of either the hard or soft palate which are of moderate extent, and which do not reach to the posterior border of the velum, it is unwise to permit an obturator to pass into the opening, thus preventing the diminution of the orifice and its possible final closure. Small openings will sometimes completely close, with no other treatment than covering the orifice.

INJURIES AND DISEASES OF THE NECK.

BY

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SURGICAL ANATOMY OF THE NECK.

THE many important structures which exist in the neck give great surgical interest to its affections. It is true that there are few organs which exclusively belong to this region. The most important structures merely pass through it from the head to the trunk. From the vertebral column with the spinal cord behind, to the windpipe in front, there are a vast number of different tissues packed into the small compass which is included under the term "neck." It is this combination of important bloodvessels and nerves, air and food passages, muscles, lymphatic and other glands, cellular tissue and fascia, which gives special interest to the surgical maladies of this region. The spinal cord, behind, is well protected by its bony case, but in front and on the sides of the neck, lie structures of the greatest importance and delicacy, which are liable to injury by accident or design.

The neck varies considerably in different persons, in both shape and length. This is mostly due to original conformation and development, but its appearance alters in no small degree, in the same person, with age, state of health, and obesity. Fat fills the hollows in females and in children more than in most adult males, so that the landmarks which define the relations of parts are in them more obscured. Among males, again, the cartilages and muscles have more prominence in some than in others. Persons with high shoulders appear to have unnaturally short necks; and the surgeon may by position so stretch the anterior and lateral surfaces as not only to render them more tense, and thus better prepared for an operation, but also to elongate the part to a considerable degree. The great mobility and rapid movements of the head, and the quickness with which the shoulder is raised on a menace of danger, so conceal the neck as to prove a powerful protection to its structures.

It is unnecessary here to dwell in any detail on the different divisions or regions of the neck which are recognized by anatomists. Suffice it to say that its boundaries are, superiorly, the line of the lower jaw, the mastoid process, and the superior occipital line to the external occipital protuberance. Inferiorly, a line from the centre of the sternum, passing along the clavicle by the acromion, to the spinous process of the seventh cervical vertebra behind. Anteriorly, the middle line of the neck, and posteriorly, the centre line from the occipital protuberance to the spinous process of the seventh cervical vertebra, complete the definition of either side. A lateral view, when the parts are put on the stretch by turning the head to the opposite side, is somewhat quadrilateral, and, being divided diagonally by the sterno-mastoid, is usually described as forming two triangles. The sterno-mastoid muscle being easily found, and having a close relationship to some of the most important structures, is always a leading guide to the surgeon.

There are a few points connected with the anatomy of the neck which it is desirable to epitomize as shortly as possible. Their direct bearing on many surgical affections renders a clear comprehension of them essential.

The *fasciæ* of the neck are among the most important of its structures. They inclose, fix, divide, and yet bind together, the various tissues and organs. The most superficial layer is continuous with that of the chest and head, and incloses in its folds various muscles, bloodvessels, and nerves. Attached at various points to bone (jaw, cranium, vertebræ, sternum, clavicle, and ribs), the cervical fascia gives firm support to the structures it incloses. Important septa pass inwards from the deep layer to be attached to the transverse processes of the cervical vertebræ, from the second to the seventh, and to the two first ribs. These, besides inclosing the roots of the cervical and brachial nerves, divide the deep portion of the sides of the neck into an anterior (larger) and a posterior region. In each of these compartments, again, each muscle has its sheath, while the great vessels, together with the trachea and œsophagus, are effectively inclosed. From this arrangement both good and harm may arise. Fluid collections, diffuse inflammation, and even new growths, make their way more readily downwards, towards the chest, than either upwards or to the side, and thus a source of much difficulty and anxiety is occasioned to the surgeon, seeing that there may be much obscurity as to the origin and relations of such affections. Growths, etc., lying above the deep fascia are readily dealt with, while those placed below it are often beyond interference. The movability of tumors, though capable of occasioning deception as to their connections, is, as a rule, a most valuable guide regarding their relation to this deep fascia. This character, together with the possibility or not of raising them, so as, as it were, to insert the fingers below them, always commands the surgeon's attention when considering the possibility of an operation for their removal.

A triangular portion of the middle layer of the cervical fascia, to which Richet has given the name of "omo-clavicular aponeurosis," has been credited by that author with the important office of keeping the great veins of the neck open, and so facilitating the return of blood from the head. This structure has its base below, and its apex at the hyoid bone. It lies on either side of the middle line, and to its outer sides the omo-hyoid muscles are attached. These muscles render the fascia tense, and in this way produce the effect above mentioned. The infra-hyoid muscles, the thyroid plexus of veins, together with the lower portion of the jugulars and the other great venous trunks at the root of the neck, being attached to offsets from it, are all powerfully influenced by its degree of tension. The risk of air gaining admission into these vessels when wounded in this dangerous region, is, however, much enhanced by the same mechanism. Fluid forming underneath the fascia, will, of course, be directed with facility into the axillæ or mediastina.

With the middle line of the neck the surgeon is often occupied, and with its anatomy he should be well acquainted. Below the symphysis we have the *supra-hyoid* space, which, if opened, will give access to the cavity of the mouth and to the tongue. A longitudinal incision in the middle line will, however, wound no structures of any consequence external to the mouth. Through such an incision Chassaignac passed the chain of the *écraseur*, in order to divide the tongue; and Regnoli, making a semicircular incision extending along the border of the jaw, drew the tongue down through the opening, and was thus able to excise its anterior half. Close below the jaw lies a lymphatic gland, which occasionally inflames and suppurates, and if not opened may leave an ugly mark. Sebaceous cysts are also met with in this region, and may attain so considerable a size as to project in the floor of the mouth, as well as below the jaw. Hydatid cysts have also occasionally been seen here. Ranula, when large, may cause considerable bulging in the supra-hyoid region. It is not always easy to recognize small fluid collections in this part of the neck, from the softness and pliancy of the structures. By pressing the finger into the floor of the mouth, close behind the symphysis, the parts will be steadied and the presence of the fluid more easily distinguished. The *hyoid bone*, though buried in the tissues, is easily recognized by its resistance and horse-shoe shape. From its floating so much it is displaced with facility. The cornua, passing outwards and backwards, serve as important guides to the surgeon in seeking for the lingual arteries. The *submaxillary* and *sublingual glands*, with the surrounding lymphatic glands, the lingual, sublingual, facial, and submental bloodvessels, together with the lingual, hypoglossal, and other nerves, lie in the supra-hyoid region. The *hyo-thyroid membrane*, with the small superior laryngeal artery (a branch of the superior thyroid, of the external carotid) and nerve upon it, comes next. A wound in this region might implicate the epiglottis. The upper part of the larynx may be reached by an operation, suggested by Vidal and Malgaigne, for gaining access to abscesses in the glosso-epiglottidean folds, or to polypi or foreign bodies not otherwise accessible.

A *bursa* lies on the anterior surface of the thyro-hyoid membrane, and passes under the hyoid bone. If this bursa enlarges, it will give rise to a small, tense, fluctuating and chronic tumor, which may finally end in a fistula. The "*pomum Adami*," below this, with its notch at the point of union of its wings, is a well-known landmark on the front of the neck. The projection of this cartilage varies in different persons, and is more pronounced in males than in females. By keeping the notch in line with the chin and the supra-sternal hollow, the middle line of the neck is easily retained. The thyroid cartilage ossifies comparatively early in some persons. It can be divided with safety in the middle line, for the removal of foreign bodies, growths, etc., but of course any deviation from the central line will cause risk to the vocal cords. A small, serous, subcutaneous bursa lies in front of the thyroid cartilage.

Below the thyroid cartilage comes the *crico-thyroid membrane*. It is slightly depressed, and has a minute artery distributed to it. In this membrane the operation of laryngotomy is performed. Next comes the ring-like *cricoid cartilage*, which is readily distinguished by its greater firmness and resistance. It corresponds in level to the sixth cervical vertebra, and is of great interest to the surgeon in connection with tracheotomy, laryngo-tracheotomy, ligature of the common carotid, œsophagotomy, operations on the thyroid body, etc. At the level of this cartilage also, the pharynx becomes œsophagus, and is at the point of junction so narrow as to be liable to arrest the passage of foreign bodies and instruments. The *carotid tubercle* on the transverse process of the sixth cervical vertebra, against which the carotid artery can be compressed, is found to the side of and below the cricoid cartilage.

After the cricoid, comes the *trachea*, with the *isthmus of the thyroid gland* covering the second, third, and fourth of its rings. The breadth of this connecting bridge varies very much in different cases, being usually broader and more developed in females. In thin persons, the upper rings of the trachea can be traced when the finger is pressed over them. The thyroid lobes, lying upon either side, are not easily distinguished unless enlarged. They rise and fall with the windpipe, and, when increased in size, the superior thyroid arteries can be felt pulsating on their upper and anterior surfaces.

When there is great hypertrophy or other enlargement of the thyroid bodies, the isthmus may cover the whole of the front of the windpipe, and form a pyramidal body, ascending even to the hyoid bone.

Compression of the windpipe, and impeded flow of blood, both in the veins and arteries of the neck, may be produced by the mechanical pressure of the thyroid lobes and isthmus, and so disturbance within the cranium may follow. When enlarged, the bloodvessels in the isthmus may become formidable and dangerous to wound.

The trachea gets deeper and deeper as it descends to the chest, and in fat persons may, as it passes behind the sternum, be an inch and a half distant from the surface.

The *thymus* may present itself in young children as a considerable tumor in the supra-sternal notch. In exceptional cases it has been known to rise high up in front of the neck.[1]

Lymphatic glands, the first of the bronchial chain, also lie above the notch. They occasionally enlarge and suppurate profusely, in young, delicate persons, and as a pulsation is communicated to the abscess by the great vessels which lie close to it, such a swelling has been mistaken for aneurism of the arch of the aorta. A deep and unsightly scar is often left after the healing of such suppurations. If these glands become much enlarged, they may by their pressure produce "false croup."

The distance between the top of the sternum and the vertebral column, is on an average two inches; that between the cricoid and the sternum, when the neck is in its usual position, is about an inch and a half; but in paroxysms of dyspnœa, these two points may be closely approximated.

In front of the trachea, arranged chiefly in a longitudinal direction, lie the *thyroid veins*, and, it may be, an *anterior jugular vein*. Numerous lymphatic glands also exist close to the windpipe. Behind the thyroid veins lies, in those unusual cases in which it exists, the *middle thyroid artery*, first described by Neubauer. Originating from the aorta, it passes straight up in front of the trachea to the isthmus, and would of course cause a complication in tracheotomy.

The *œsophagus*, at first placed behind the larynx, comes to be deflected to the left side so that it can be opened clear of the windpipe. Deep in the groove between the trachea and œsophagus, on either side, lie the *recurrent laryngeal nerves*. They are not disturbed when the œsophagus is reached by Nélaton's method of keeping close to the trachea in order to avoid the carotids. It may be here noted that neither the shape, consistence, color, nor movements during deglutition, form reliable guides to the œsophagus when it is to be opened on the living subject. It is only by feeling for the foreign body (if one be present), or better still, by passing down a sound from the mouth, that confidence and safety in opening the gullet can be insured.

Both the superficial and deep layers of the cervical fascia meet in the middle line of the neck, but the platysmas (which are inclosed in the fascia) only do so at the upper part. The pre-tracheal muscles lie on either side of the middle line, and are united by the aponeurosis which crosses over it. The windpipe and œsophagus are very movable, both laterally and vertically, in consequence of the loose bed of cellular tissue in which they lie. This freedom of motion is essential to their function, but it increases the difficulty of the operator in dealing with them. The sheath of fascia which incloses the trachea and œsophagus, accompanies them into the chest, so that pus getting access to its interior may pass into the mediastinum. The writer has known a post-pharyngeal abscess to cause death by bursting into the chest.

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[1] Allan Burns, Observations on the Surgical Anatomy of the Head and Neck, 2d ed. Glasgow, 1824.

This sheath is connected on either side with that of the great bloodvessels, and in front with the omo-clavicular aponeurosis before alluded to. From all that has been said, it is apparent that tracheotomy may become one of the most difficult and anxious operations, especially in young children with short fat necks, who have had sinapisms and poultices applied, and in whom the veins are distended from impeded respiration, especially if the thymus be also enlarged.

From the tenor of what has been said, it may be inferred that the middle line of the neck, from the chin to the sternum, is the safest place for incisions to be made. The structures become more and more dangerous to interfere with, as we diverge on either side. In all cases in which it is possible, deep abscesses lying near the middle line are best got at by an incision in the centre, followed by the use of dressing forceps inserted along the groove of a director, as recommended by Mr. Hilton. Other positions in which incisions can be made with safety, are along the line of the lower jaw and behind the sterno-mastoid, where, too, the director and forceps should be employed for completing the deeper parts of the incision.

Finally, the space which intervenes between the posterior edge of the *sterno-mastoid* and the anterior limit of the *trapezius*, is of much interest to the surgeon. It varies considerably in extent according to the development of these muscles. The posterior belly of the *omo-hyoid* can, in thin persons, be seen like a cord running athwart the neck, nearly parallel to the clavicle. The pulsations of the *subclavian artery* can also be detected close to the external edge of the sterno-mastoid, which edge again closely corresponds to the outer border of the *scalenus*, the first guide to the ligature of the subclavian in the third part of its course. The artery can be here compressed by the thumb (the surgeon standing behind the patient), or by a padded key-handle or roller-bandage pressed downwards and somewhat inwards, so as to bear directly on the tubercle of Lisfranc. Lastly, the *external jugular* vein is visible in many people between the sterno-mastoid and trapezius.

As was before remarked, the neck escapes injury in a remarkable manner through the great protection afforded it by the head and shoulder. Yet contusions and wounds (homicidal and suicidal), burns, and morbid growths of various kinds, have to be dealt with. In the following remarks, injuries of the spine are not considered, nor are affections of the larynx, trachea, and œsophagus; nor yet the affections and operations connected with the great vessels of the neck, these subjects being all discussed in other articles.

Contusions of the Neck.

Contusions of the neck, if violent, may cause insensibility, and even death, from shock or spasm. The hyoid bone, or the laryngeal cartilages, may be broken or crushed. It is well known that these structures may be seriously injured by the grasp of a garroter, or by the rope in hanging, or by the passage of a wheel, or by a fall on a pointed body. A violent blow with the fist alone may very seriously injure the larynx, and be followed by dangerous symptoms.[1]

Fractures of the hyoid may implicate the body or the wings. The fragments may be displaced, or not. This accident is said to have been caused by muscular action alone. (Ollivier.) The fragments may project so as to cause a visible deformity. The *cartilages* may be driven inwards or to one side. They have been driven through the mucous membrane, and have occasioned severe bleeding. Much bruising, swelling, and pain accompany these accidents, and all movements of the parts or of the tongue, as in articulation or deglutition, become both difficult and painful. The *trachea* has been ruptured and yet no wound has existed externally. (Bryant.)

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[1] Lalesque, Jour. Hebdomad., Mars, 1833; Auberge, Revue Médicale, Juillet, 1835; Orfila, Médecine Légale.

An attempt by manipulation may be made, under chloroform, to restore any displaced fragments, but such measures are difficult and seldom succeed. If replaced, they may be secured by adhesive plaster, or by fixing the head on a pillow, with the neck straight or bent according as the parts are found most relaxed. Easily swallowed food should alone be given, and it may be necessary to use the stomach-pump for alimentation. If there be much laceration, it will be almost impossible to retain the fragments in place. Tracheotomy may be required if there is a threatening of asphyxia, and artificial respiration may be needed to overcome the immediate danger. If an accumulation of air or blood in the cellular tissue cause injurious pressure, an incision in the middle line may be necessary.

It has been alleged that the *hyoid bone* may be *dislocated*,[1] but this observation is far from being confirmed.

Fracture of the cricoid is a very dangerous accident. It implies much violence, gives rise to shock, convulsive cough, and spasm, and is apt to be followed by such severe inflammation and swelling as to render it generally fatal. Mr. Durham gives a summary of recorded cases from Hénoque and others. He mentions sixty-two cases in all, of fracture of the bones and cartilages of the larynx, with only twelve recoveries.[2]

Necrosis may attack the cartilages of the larynx as a result of injury, but more usually it is due to syphilis. Much local and constitutional disturbance is thereby occasioned. Though this disease is usually chronic in its course, yet acute symptoms may arise at any time and induce the utmost danger. The portions of dead cartilage may be discharged with the profuse and offensive expectoration, or may cause abscesses which, after dissecting their way far and near, may allow the *débris* to escape externally. Fistulæ may thus be established, and a cachexia which is severe and difficult to deal with. All such pus-collections should be opened as early as possible, their drainage secured, and any dead and detached pieces of cartilage removed. Bronchotomy may be required at any time to relieve spasm and œdema, and this measure may be rendered desirable even to secure rest to the diseased parts, and to give time for the employment of constitutional remedies, or local applications, such as medicated air, etc.

The sterno-mastoid muscle may become the seat of swelling and effusion, from being strained at birth (*congenital tumor or induration*[3]), and one form of wryneck may be due to this cause. Violent twists of the head, falls, and even rapid and strong contraction of the fibres of this muscle, have been known to cause partial rupture in the adult, followed by sudden and distressing pain, together with considerable effusion, necessitating rest, fixation, and fomentations, with subsequent friction, for its removal.[4]

BURNS AND SCALDS OF THE NECK.

Scalds and burns are not uncommon in the neck, and, if severe, are attended with serious shock. They occasion much anxiety subsequently from the inflammation and effusion which are apt to occur within the larynx, together with the contraction and deformity which may follow. (See Volume II., pages 223, 240, 247.)

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[1] Gibb, The Hyoid Bone. London, 1862.

[2] See Holmes's System of Surgery, 2d ed., vol. ii. p. 462.

[3] See Myo-sclerosis, page 600, *infra*.

[4] Revue des Sciences Médicales, tome ii. p. 741. 1873.

WOUNDS OF THE NECK.

Wounds of all kinds have to be treated in the neck, and though in their general features they do not differ from similar injuries in other parts, yet from the mode of their infliction—being for the most part homicidal or suicidal—from the structures usually involved, as well as from the severe and dangerous complications which may follow, they are especially important and interesting. Many of these lesions are fully dealt with in other portions of this work. In the present article they can be considered but generally and concisely.

Suicide by cutting the throat is more commonly attempted in Great Britain than elsewhere, in proportion to other modes of self-destruction. Homicidal wounds of the neck are also not infrequent. All sorts of weapons have been used, and every degree of injury and very various complications have had to be dealt with. That wounds of the neck are frequently seen in military practice, is shown in the official reports of the recent European and American wars. Foreign bodies, too, may be buried and lost in the tissues of the neck.

Wounds of the neck may be superficial, and uncomplicated by the lesion of any important structure; or deep (that is, penetrating the fascia), and then they usually involve bloodvessels and nerves of importance. There may be a very extensive division of the soft parts, and yet the windpipe and great vessels may escape; while with a small, external wound, there may be serious, deep injury, the exact nature of which may be difficult to ascertain. It is by considering the nature of the weapon which has inflicted the wound; the direction and depth of its penetration; the clothing of the parts at the time; the nature of what escapes (air, arterial or venous blood, food, or mucus); the effects on the function of the larynx, lungs, œsophagus, and nerves; the occurrence or not of emphysema; and also, in case of an assault, by taking into account the relative position of the assailant to the sufferer, that a judgment is to be formed. In gunshot-wounds, it is seldom that the modern bullet is deflected from its course as the old round ball used to be, but even the conical ball, if much spent and travelling at a low rate of speed, may take a devious and unexpected course in the neck. Large, open wounds are of course easily judged of, as they admit of being examined by the eye and finger.

The *external jugular vein*, from its superficial position, may be injured in comparatively shallow wounds. Pressure will often arrest the bleeding. If not, the vessel should be tied on both sides of the wound. The entrance of air might, of course, prove a serious danger.

Wounds of the *thyroid body* may prove very dangerous from bleeding.

The lips of transverse wounds of the neck gape much, but those of longitudinal wounds, such as are made by the surgeon, seldom do so. The elasticity of the skin and the action of the platysma usually cause the lips of transverse wounds to curl inwards, and it is in order to secure their more accurate apposition that sutures have been advised in their treatment. The risk of the drainage proving insufficient, and so causing diffuse inflammation and the burrowing of pus, is, in the experience of many, a stronger argument against their use. In most cases, however, the surgeon will be enabled to employ sutures without inducing harm. The most ample provision for drainage is essential, and to secure this it may be requisite to make a longitudinal incision at the centre or other appropriate part of a transverse wound, and not to close the more dependent part under any circumstances as long as there is any discharge. If sutures are used, they should be placed close to the edge of the wound; and adhesive plaster, with careful position, should be employed to support the stitches and keep the platysma at rest. The sutures may be of catgut, horsehair, or wire, as is thought most appropriate, and antiseptic dressings can be perfectly adapted to superficial wounds, though primary union is not usually got throughout, however desirable it may be to obtain it. The appearance of swelling or erythema, or any evidence of pressure, will make it necessary to remove the sutures partially or completely.

Wounds of the neck which involve the *air-passages*, *great vessels*, and *nerves*, are of course extremely dangerous, and often rapidly fatal. The air-passages alone are not uncommonly involved. The suicide, as has been often remarked, frequently fails in his purpose by cutting high and throwing his head too far backwards. In this position the windpipe is advanced, and the carotids are covered by the sterno-mastoids, which become tense. When, on the other hand, the wound is inflicted lower down, the resistance of the laryngeal and tracheal cartilages, the spasmodic contraction of the sterno-mastoid muscles, and the greater depth at which the carotids lie, frequently save those vessels from being wounded. Mr. Hilton suggests that when the air-passages are opened below the glottis, and air escapes from the lungs, the muscles connecting the chest and arms are so weakened as to diminish their power of action. The carotid arteries have been laid bare by the suicide, and yet not opened, and well-authenticated cases have been recorded in which both the trachea and œsophagus have been wholly divided, and yet both the carotids and jugulars have escaped. Very free bleeding may attend wounds of the forepart of the neck, and prove highly dangerous to weak patients, even although the great bloodvessels be not wounded. There are also many irregularities and abnormalities in the size and distribution of the bloodvessels in this region, which may render wounds especially dangerous.

If the *carotids* are wounded, rapid death will probably ensue, unless fainting occur and give time for surgical aid, or the irregularity and narrowness of the wound prevent the rapid escape of blood. No doubt, if skilled help were at hand, death might in some cases be warded off by pressure, followed by ligature of both ends of the artery, or by ligaturing the lower end and compressing the upper, as may be seen in cases related by Larrey and Hodgson. The former has recorded instances in which the ligature of the main vessel on the proximal side alone, succeeded in arresting hemorrhage, but this must always prove a most unsafe proceeding, and that it fails in practice is shown by the cases related by Breschet in his notes to Hodgson. Compression can with some success be applied to the common carotid, but as there is no firm point of support behind the external and internal carotids, there is little use in attempting it in wounds of these vessels.

Wounds of the *great veins* of the neck are particularly dangerous, not only from hemorrhage but from the risk of admission of air. The free anastomosis between these vessels greatly favors bleeding. The occlusion of one of the jugulars is not without danger from inflammation occurring within it, and also from the disturbance which follows in the circulation within the head. It is in the later stages of the operation of excising growths that the jugulars are most apt to be wounded, when the tumor is drawn forwards in order to divide its posterior connections, and any adherent veins are in this way put upon the stretch. A part of the vein may be thus excised, and air may rush in with an audible sound, rapidly occasioning the utmost danger. I have twice witnessed this accident, but the danger in each case was overcome by rapidly applying pressure, followed by ligature of the wounded vessel. The hissing, sucking, or whistling sound, as it has been variously described, is quite peculiar and distinctive, while the sudden blanching of the face and tumultuous action of the heart which follow, but too surely indicate what has occurred. Such an occurrence may follow wounds of any of the great veins in the "dangerous region" at the root of the neck, but it has been most often seen in the jugular, subclavian, and axillary veins. A large opening is not necessary. Erichsen[1] relates a case in which entrance of air took place, and was followed by death, during the passage of a seton into the forepart of the neck, and Le Gros Clark has shown that the air may be so slowly drawn in by the orifice of a half-divided, small vein, as not to evidence itself at the wound by the usual signs.[2] In narrow wounds, where the opening in the vein and that in the soft parts have lost their parallelism, the neck may be extensively infiltrated.

Pressure should in all such accidents be at once applied, till the vein is tied above and below the wound. It is better to tie the vessel completely, even though its calibre be but partially divided, rather than pick up the orifice alone in the hope of not obstructing the vessel, as was at one time recommended. In an elaborate study of the subject, Professor S. W. Gross has with his usual ability dealt with these lesions of the great veins.[3]

When the *thyroid body* is wounded the bleeding may be very profuse, and difficult to arrest from the very free anastomosis which exists between its vessels. Both arteries and veins bleed violently, the veins especially, if the respiration is embarrassed. To tie these vessels is very difficult, and pressure cannot be borne. In some cases it might be possible to pass a needle under the bleeding point and apply the twisted suture.

The various *nerves* of the neck, especially those connected with the arm, may be involved in wounds. Bullets have frequently injured the cervical nerves, and paralysis with wasting has followed. The pneumogastric and phrenic nerves may also be cut, when the carotids are divided, and bullets have occasionally injured both these nerves as well as the sympathetic, though few such cases have been described in detail.

The most common position for suicidal and homicidal wounds has been made the subject of statistical inquiry. They have been most commonly seen at or about the thyro-hyoid membrane, or a little below it.[4] In assaults, the chin being depressed has protected the upper part of the throat. Gunshot wounds may, however, occur anywhere, and portions of the throat may be in them even torn away. Wounds in the supra-hyoid region may open the cavity of the mouth, wound the root of the tongue, and partially or even wholly detach the epiglottis. Suffocation may be caused by the entrance of blood or other matters into the air-passage, or by the epiglottis or the tongue occluding its orifice. Swelling and œdema, which usually follow, may also occasion danger. The facial and lingual arteries with the hypoglossal and other nerves, may be injured in such high wounds, and fatal bleeding may follow if efficient surgical aid cannot be obtained. These vessels can, however, be readily ligatured. In wounds lower down, besides the windpipe, the arytenoid cartilages and vocal cords, and the aryteno-epiglottidean folds, may be involved, with the lingual and superior thyroid arteries, the superior laryngeal nerves, and even the carotids.

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[1] Science and Art of Surgery, 5th ed., vol. i. p. 418.

[2] Lectures on the Principles of Surgical Diagnosis, etc., p. 225. London, 1870.

[3] American Journal of the Medical Sciences, 1867.

[4] Durham, in Holmes's System of Surgery, gives a summary of 158 unselected cases, from which it would appear that 45 of the wounds were through the thyro-hyoid membrane, 35 through the thyroid cartilage, 26 through the crico-thyroid membrane or cricoid cartilage, 41 into the trachea, and only 11 above the hyoid bone. Horteloup and Sarazin have also published statistics upon this point, but the teaching from these figures is of little moment.

When the *epiglottis* is divided, besides the danger of suffocation, the speech, respiration, and deglutition, will be affected, and the latter perhaps rendered impossible by spasmodic cough. A wound in this region gapes more or less, and the food (especially liquids) will probably escape. If the thyroid vessels, jugular veins, and thyroid body are involved, the hemorrhage will be very profuse and probably fatal. The recurrent laryngeal nerves may also be implicated. Thirst is a frequent, though not universal, complaint in these wounds, and there is great risk of serious complications such as diffuse cellulitis, producing great swelling and œdema, and attended with great constitutional disturbance. The edges of incised wounds are often very irregular, from the skin not having been stretched at the time it was cut. Suicidal wounds are especially apt to be attended by serious complications, on account of the state of health of the patients who are their subjects. Such wounds are frequently inflicted during a period of temporary insanity caused by intemperance, when the whole system is out of order.

The *air-passages* have been wounded in every possible way, and with wounds of the most diverse descriptions. Every species of wound has been met with, and foreign bodies of many sorts have been driven in from without. The records of surgery supply a curious collection of such accidents. The surgeon makes his incisions in the axis of the windpipe, but homicidal and suicidal wounds are usually more or less transverse.

Suicides sometimes so hack and cut the throat that portions of the cartilages may be wholly detached and removed, as occurred in an extreme degree in a case under my own care. These wounds may be very irregular, and attended with much laceration of the soft parts. If the larynx or trachea are only partially divided, the wound will not gape much, but if the division be complete (which is not common), the separation of the lips may be very considerable.

The *œsophagus* may be severed as well as the air-tube, by one stroke of the knife. I saw this lesion in the case of an intemperate surgeon who committed suicide, and who, from notes found among his papers, had evidently studied the subject carefully. The whole of the tissues on both sides of the neck, including the great bloodvessels, were divided, and even the spinal column was marked by the blade of a long, sharp amputating knife which he had used. When the wound is sufficiently deep to implicate the air-passages, the complications which may occur early or late are gaping, bleeding (which will vary with the direction and extent of the wound), and the escape of air and mucus, and possibly of alimentary matters, if the wound be high in the neck. Aphonia and various alterations of the voice, together with difficulty of breathing and emphysema, may also be present. The latter condition will appear when the orifice is so narrow as to allow the air more readily to penetrate the cellular tissue than to escape externally, and in that case it may possibly extend far and wide, especially downwards along the trachea and œsophagus into the mediastinum, and, according to Horteloup, it may even reach the scrotum. Death will be rapid if the great bloodvessels are largely opened, but when the wound is small, life may be saved by fainting. Secondary hemorrhage, days or weeks afterwards, may end life.

Effusion into the glottis and cellular tissue is one of the menacing dangers, especially in narrow wounds. The whole interior of the air-passages, from the glottis to the minute divisions of the bronchial tubes, may become involved, as well as the substance of the lung itself. This may be due to the mere extension of the inflammation, or to the admission of cold air, or of foreign bodies. Suppuration too may eventually arise at the wound, and pus may dissect its way far and near in the cellular tissue of the neck. If recovery from these conditions follows, permanent contraction of the air-passages, with aphonia and fistulous orifices, is likely to remain. There are a few instances in surgical literature of the entire obliteration of the upper part of the larynx, and that too without the entire loss of the voice. In these rare cases, the air has gained admission to the vocal cords by the external wound. Suffocation may, however, threaten, from the contraction of the passage and the adhesion to surrounding parts preventing movement. Fistulæ (which under ordinary circumstances are not common) are, for the most part, due to loss of substance, or to such gaping of the lips of the wound as treatment fails to counteract. They are very difficult to repair.

It may be here said that *spontaneous rupture of the trachea* during violent fits of coughing has been said to occur, but the fact is somewhat doubtful, and is of too little practical interest to be dwelt upon.

Bullets, poniards, etc., may reach the pharynx or œsophagus, either through the mouth or by the side of the neck. Jugglers have fatally wounded themselves in passing swords down their throats. Mr. White relates a remarkable case in which a navvy fell backwards upon a small, sharp pick, which penetrated his neck, and, passing between the carotid vessels, pierced the pharynx immediately behind the posterior pillar of the fauces. The man made a rapid recovery.[1] Insane persons have inflicted serious wounds on these parts through the mouth; and bougies, forceps, etc., used by surgeons, have caused laceration and rupture. Even violent vomiting is said to have ruptured what appeared to have been a sound œsophagus. Punctured wounds in which both the air-passages and œsophagus have been penetrated, are uncommon, yet in deep transverse or oblique wounds they may both be involved.

Wounds of the pharynx and œsophagus are said to occasion pain, spasm, hiccup, dysphagia, thirst, and a feeling of constriction amounting almost to suffocation. The escape of alimentary matters is not constant, and its occurrence does not necessarily show that the food-passage has been opened. If the glottis, as the result of swelling or diminution of its nerve supply, loses its sensibility, as it occasionally does in the later stages of wounds of the air-passage, it may no longer act as a barrier to the passage of foreign bodies, and thus food may gain admission into the windpipe and appear at the wound; but although the escape of alimentary matters is thus not diagnostic of a wound of the pharynx or œsophagus, yet it is in any case a serious symptom, as it implies a grave lesion.

Wounds of the *back of the neck* may either involve the soft parts alone, or penetrate into the spinal cord. In the latter case they are quickly fatal, but in the former they may be very extensive, and yet not cause death.[2]

The difficulty in dealing with deep and extensive flesh-wounds in the back of the neck, is to keep the head fixed in a good position and to provide effective drainage. The well-known observations of Larrey, as to atrophy of the testicle and paralysis of the lower limbs following such wounds even when the brain and cord have apparently escaped, have not been verified by more recent experience.

In France, it is said that infanticide is occasionally accomplished by inserting a needle between the axis and atlas, a mode of murder very difficult to detect.

The *prognosis* of such wounds of the neck as are not rapidly fatal, is not always easy. The part wounded and the depth of the lesion are often more important than its extent; but the opinion formed of the result will in all probability chiefly turn on the complications which may exist. All wounds in this region are of course liable to the same accidents as similar injuries elsewhere, but they have, besides, special dangers of their own, and even slight wounds may become the source of the utmost anxiety. Inflammation followed by extensive and rapid effusion may arise at any time and occasion the utmost danger. The great risk is interference with the breathing, and it has been shown how many conditions may cause this either early or late. Small wounds of the air-passages are sometimes more dangerous than large ones, from imperfect drainage.

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[1] British Medical Journal, vol. ii. p. 146. 1876.

[2] See Legouest, Traité de Chirurgie d'Armée; Surgical History of the War of the Rebellion; and the author's Notes on the Surgery of the War in the Crimea.

The weak and irritable condition so often present in suicides, insane persons, and the old, renders their wounds more liable to complications. Persons suffering from delirium tremens, as is well known, are peculiarly apt to suffer from low inflammation and rapid exhaustion. That, however, there is always hope of recovery even in the most desperate cases, is amply shown by the records of surgery. Many instances exist of recovery following the most extensive, and, at first sight, hopeless-looking wounds, and this sometimes in most unpromising patients. When the bleeding can be stayed and the breathing kept free, we need never despair.

As to the *treatment* of wounds of the neck, it is manifest that the leading indications are to command the bleeding, secure free respiration, and overcome shock. To accomplish these ends, the same measures are employed here as in other wounds, and do not call for detailed remark. If, in order to fulfil these purposes, it be requisite to enlarge the original wound, the surgeon must not hesitate. To secure all the wounded bloodvessels may not be easy, and requires much precious time. A ligature should be applied to both ends of divided vessels, and upon either side of punctured wounds. In narrow, deep wounds, the difficulty of carrying this out is very great. Pressure is almost impossible to apply effectively, even in superficial wounds. Pressure-forceps, if quickly applied, will, however, be of much service by giving time for the application of ligatures.

The entrance of blood into the windpipe must be carefully prevented, and if necessary a large tracheal tube must be inserted, and the space round it closed by plugging. The trickling of blood into the air-passages will, in a weak or fainting patient, readily occasion slow and insidious suffocation. Hemorrhage from small veins is best arrested by keeping the respiration free. Other sources of embarrassed respiration, such as the semi-detached tongue, or epiglottis, or cartilage, must be attended to.

If dangerous emphysema arise, it may be necessary to enlarge small and narrow wounds; but otherwise, unless there be bleeding or deficient drainage, they are best left alone.

The use of sutures in wounds of the throat, has given rise to much controversy. Their careless employment has occasioned so much harm as to have led to their general condemnation. Modern surgery, however, does not so rigidly exclude their use in all cases as was done some years ago. It is true, and cannot be too strongly insisted on, that if the breathing, or drainage, be in any way obstructed, or emphysema caused, by their presence, then nothing but harm and danger can come from their use. Good and not evil will, however, follow by approximating the lips at the ends of long wounds by a few stitches, so as to counteract the great gaping, and this will be the more necessary if the trachea be entirely divided, and if it retract much, as it is apt to do. It is seldom that the larynx or trachea themselves require to be stitched, and when that has been attempted, good results have rarely followed. It is the centre of the external wound which it is of most consequence to leave open, and if at any time indications of deficient drainage or imprisoned air appear, any stitches which have been introduced should be removed. The head should be fixed in such a position as may promote the approximation of the lips of the wound, and relieve tension, while not interfering with the escape of discharges. There are various methods of accomplishing this. Putting a night-cap on the head, and attaching it to a body band by tapes, while the head and shoulders are raised, serves the purpose in most cases. All speaking and movement, as in swallowing, should as much as possible be avoided, and watchful nursing is essential, especially in suicidal cases.

Sutures may be used to unite wounds of the œsophagus, if position fail to approximate the divided parts. Drainage must of course, in all cases, be carefully secured. In the early stages of treatment, deglutition should be avoided as much as possible, and for this purpose we must resort to the use of carefully prepared enemata. A tube may be passed into the stomach either by the wound or by the mouth, but as soon as cicatrization has begun the former method must be avoided. In any case it is bad practice to leave the tube in place, and if its passage cause much inconvenience, enemata must alone be relied on. Legouest suggests a method of passing the œsophageal tube by first introducing a small urethral bougie by the wound into the lower end of the œsophagus, and attaching to its upper extremity, by means of a small sound passed from the buccal cavity downwards to the wound, a long thread which is brought out by the mouth, and then using the thread and bougie as a conductor for the œsophageal tube. During cicatrization, the calibre of the canal must be retained by a careful and judicious use of bougies.

Thirst is a serious annoyance in such cases. Small bits of ice put on the tongue relieve it, but have the disadvantage of causing frequent acts of swallowing. As soon as healing has well advanced, unirritating fluid food may be allowed. If there be much exhaustion, milk, broths, and other forms of concentrated nourishment must be administered.

The air respired should be moderately warm and moist, without being exhausting. A temperature of between 70° and 80° Fahr. suits best. The entrance of foreign bodies must be prevented by covering the wound with moistened muslin. If dyspnœa occur, its exact cause must be sought for and remedied. The base of the lungs should be frequently and minutely examined. By temporarily closing the wound, the patient will be enabled to eject fluid which he cannot otherwise get rid of. Inflammation in any part of the air-passages, lungs, or pleuræ, must be constantly watched for and promptly treated. It may come on very insidiously and spread rapidly. Œdema of the glottis is a most serious complication. It may be dealt with by the usual remedies, or by introducing one of the tubes described by Dr. McEwen.

The healing of the wound must be supervised, and exuberant granulations, if they occasion obstruction, repressed by appropriate means. Restlessness and excitement may require to be combated by the subcutaneous use of morphia. Tracheotomy low down in the tube may be reasonably considered when the wound is more than usually difficult to manage, especially if signs of obstruction follow its closure. The rest thus gained will promote the healing of the wound, and the dilatation of a contraction following the cicatrization will be better managed from below than by passing instruments from the mouth. In some cases the laryngoscope may prove serviceable in dealing with such contractions. Abscesses, if they form, must be effectually drained. Schrötter proposes to render the larynx insensible by the application of a saturated solution of acetate of morphia, after having first increased the capability of absorption of the membrane by touching it repeatedly with pure chloroform. This is done the night before an operation is to be performed. An hour should elapse between the applications of the chloroform and the morphia.

ABSCESSES OF THE NECK.

Abscesses of the neck of various kinds (acute and chronic, circumscribed and diffuse, superficial and deep) are common from the large amount of cellular tissue present in its structure.[1]

Abscesses may be due to many causes, such as injuries and diseases in the soft parts, or bones, or glands; affections of the sockets of the teeth (especially the last molars), of the pharynx, œsophagus, air-passages, and thyroid body; irritation any where over the scalp, in the ear or the cavities of the face, in the tongue, etc. The most serious abscesses are perhaps those which occur in the course of low fevers. They are not infrequent during scarlet fever, measles, and smallpox. The scrofulous diathesis is always a powerful, predisposing cause. Purulent collections in the neck make themselves known by signs similar to those which appear in affections of a like kind in other parts, but they are remarkable from the great swelling, œdema, and tension, together with the embarrassment of function which they occasion.

The effects produced will vary with the position of the pus as regards the cervical aponeurosis. If it be superficial to the fascia, it will usually be circumscribed, and come quickly to the surface; but it may fill the whole side of the neck, extend to the clavicle, and even descend in front of the chest. When deep, the pressure-effects may be very serious.

Abscesses rarely form in the nape of the neck, though occasionally they arise there in connection with the glands. From being firmly bound down they occasion great pain, and take long to come to the surface. Fluctuation is not easily recognized. They should be opened early.

Inflammation of the gland below the chin may cause great swelling, invading the floor of the mouth. Mastication and deglutition are embarrassed by the pain. By pressing down the floor of the mouth with one finger, so as to steady and render tense the swelling, fluctuation can be more easily made out. The pus generally points under the chin, but it may pass backwards towards the pharynx, or downwards along the windpipe or great vessels even into the chest. Alterations of voice, and inflammation within the air-passages, may result from pus formations in front of the larynx. The sheath of the sterno-mastoid may be filled with pus so as to render its movements both painful and difficult, and one species of wryneck may arise from the contraction caused by inflammation of this muscle. The great sources, however, of cervical abscess, are the lymphatic glands so numerous in this region, and so liable to irritation. Though occasionally no explanation, unless it be a state of depressed health or cold, can be found for these glandular affections, yet as a rule, if carefully sought for, evidence will be found of irritation, somewhere in the wide circuit of the lymphatic vessels leading to these glands.

The worst form of cervical abscess arises when the cellular tissue becomes involved after injury or after scarlatina. The whole side of the neck may become one hard mass, which slowly suppurates and causes extensive destruction. Violent and fatal bleeding may follow in these cases, even days after the abscess has been opened, and constitutes one of their most serious complications. Persons of enfeebled health are most liable to these formidable affections, and their lives may be placed in great jeopardy by the pain, fever, pressure-effects, and prostration. Serious complications too may follow. Beside the pressure on the bloodvessels, nerves, air-passages, and œsophagus, there may be sloughing and ulceration, with serious and even fatal hemorrhage; diffuse inflammation, passing far and wide even to the chest and axillæ; thrombi in the great vessels, with embarrassment of the circulation in the brain and lungs; and, above all, blood-poisoning.[1]

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[1] See Vol. IV., page 928 *et seq.*, for those connected with the vertebræ.

Cervical abscesses, if placed near the great vessels, may receive a transmitted pulsation which will cause the surgeon to hesitate as to their diagnosis from aneurism, especially as they cannot always be raised up or pushed aside so as to be freed from the influence of the vessel.

The distinction is to be made by observing the difference in clinical history of the two cases, and the ages at which they occur; the pulsation is not expansive, nor as distinct as in aneurism, and the swelling is less defined in its outline, and more superficial and diffused. In abscess, too, there will be signs of previous inflammation, probably involvement of several glands, and of the skin, and the existence of fluctuation. If an aneurism have burst into an abscess, then the difficulty of recognizing the true condition of affairs will be greatly increased.

Post-pharyngeal abscess will demand consideration in the article on affections of the throat.

Suppuration rarely occurs in the thyroid body, but, when it does, it manifests itself by the usual signs of local inflammation, accompanied by much constitutional disturbance. It is attended by much swelling and œdema of the neck, and the pressure-effects are considerable. The thyroid may even undergo sphacelation and be destroyed, and that without necessarily producing fatal results, nor even much inconvenience from its loss.

Pus placed deeply in the neck may be very difficult to distinguish clearly. Fluctuation may not be recognizable, from the slight resistance of the surrounding parts, and from the firm way in which the pus is bound down. Elasticity alone may be present, but the œdema, diffuse redness, and pain, form important guides to diagnosis, unless the abscess be of small size and very deeply placed, when neither redness of the surface nor swelling may be marked.

Chronic abscesses of the neck are almost always of constitutional origin, or the result of degeneration of the glands, or of disease of some of the bones or cartilages. Sometimes these pus-collections are "residual," or the result of former inflammatory action which has left its products behind to remain quiescent for a time, and to recover their activity when the general health has from any cause become deteriorated. These abscesses are of very slow progress, and are important chiefly from the evidence which their appearance gives of weak, local and general conditions. They are often attended by very little disturbance. They may burst by several small openings which become either troublesome sinuses, or the starting points of ulceration which spreads and is difficult to repair. From the absence of much pain, and from the slow formation and advance of these pus-collections, they might be mistaken for cysts or other tumors; but a regard to the diathesis of the patient, the clinical history of the affection, and the probability of other abscesses of a similar nature having existed, together with a careful examination of the local condition, will indicate their character. Unhealthy children who have been exposed to bad hygienic surroundings are the most common subjects of these abscesses.

Treatment.—It will of course be most important to prevent the formation of pus, by removing, if possible, the irritation or cause, local or constitutional, upon which it depends, and by the use of such local antiphlogistics as may be required. In some cases counter-irritants, in the form of embrocations containing iodine, or even of blisters used for short periods, as recommended by

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[1] Gross, Amer. Jour. Med. Sci. 1871.

Velpeau,[1] may be of use, but these are in the majority of cases more than doubtful remedies, unless it be in the later stages, to remove the chronic hardness which may remain. When pus has formed, the sooner it is evacuated the better. Its presence can only do harm, and it is best got rid of by such a free incision as may, if possible, obviate the need of repeating the operation or of using drainage tubes, or of any squeezing or handling afterwards. The abscess should be opened antiseptically, and its drainage carefully attended to. Capillary punctures can only be of use in the case of very limited collections. Their supposed advantage is the avoidance of a scar, but this is frequently illusory, and as a rule they are very unsatisfactory, and give much more annoyance by the necessity for their repetition than by any good which they can produce. The use of the aspirator, hypodermic syringe, trocar, or grooved needle, vaccination, and the introduction of setons of linen, metal, catgut, or other threads, capillary tubes, etc., are all ineffective, and are apt to cause greater subsequent evils than a free, clean cut.

Deep abscesses require careful management. The plan of opening them recommended by Mr. Hilton is a great improvement on the ordinary method. After incising the superficial and less important parts, a blunt director is carefully pushed down through the tissues, separating without cutting them; when the pus is seen to well up along the groove, a pair of dressing forceps is pushed in with the blades closed, and when within the cavity these are expanded, so as to enlarge the opening to the necessary extent. In incising the structures, if the knife be used, they should be carefully and slowly divided layer by layer, so as to allow of their being recognized as we proceed. Advantage should be taken of all natural shadings in the skin so as to reduce subsequent scarring to the last degree. Of course these abscesses should be opened at their most dependent part, and sufficiently freely to provide for drainage. Chassaignac[2] and more recently Professor Marshall have shown how easily and safely deep abscesses at the side of the neck, below the deep fascia, may be evacuated by an incision in the middle line in front of the trachea, and how far back we can seek for the pus by keeping close to the windpipe. Incisions may also be made behind the sterno-mastoid, as well as along the base of the lower jaw-bone. The cavity of large abscesses may have to be washed out with a weak solution of carbolic acid or iodine, but great care must be taken not to force any of the fluid so used into the cellular tissue of the neck. Sinuses too may require to be split up in order to promote their closure, and indurations may need to be got rid of by blisters, colorless iodine, or mercurial embrocations, while constitutional treatment will also in most cases be required to strengthen the system and improve the nutrient qualities of the blood.

FISTULÆ IN THE NECK.

Cervical fistulæ may be either congenital or acquired.

1. CONGENITAL FISTULÆ, called "branchial" by Heusinger, were erroneously called tracheal fistulæ by Dzondi, who first drew attention to them in 1829. Ascherson[3] first ascribed the affection to its true cause, viz., an arrest of development in the closure of the pharyngeal fissure or cleft. The closure of the branchial arches, which terminates about the end of the second month of fœtal life, will, as is well known, if arrested, give rise to various con-

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[1] Gaz. Méd., Avril, 1871.

[2] Gaz. des Hôpit. 1843.

[3] De fistulis Colli. 1832.

genital deficiencies, of which cleft palate, hare-lip, and deformities in the ear, form a part with these fistulous orifices.[1] These fistulæ usually communicate with the pharynx, though in rare cases they are found to open into the trachea or larynx. Though usually present at birth, they have been in some cases apparently overlooked, or at least not brought under medical observation till the patient has attained adult life. They have been found in several cases to be hereditary, occurring in several generations, and, in one case, affecting five children out of eight. They have been usually seen on the right side of the neck, behind or in front of the sterno-mastoid muscle, somewhere between the thyroid cartilage and the sterno-clavicular articulation. In rare cases they have been seen as high as the angle of the jaw. More rarely they have been met with in the middle line, or on both sides, in corresponding positions. They may be complete, that is, communicating with the external surface and the pharynx, or incomplete in so far that no internal opening can be found. Authors have also spoken of such fistulæ having an internal and no external orifice, though there does not appear to be good reason for such a statement. Generally they are very small, admitting a probe with difficulty, but they have been seen large enough to permit the introduction of the point of the little finger. The external orifice is occasionally found upon a small projecting mass of granulations, or it may be concealed under a fold of the skin. A thin, viscid fluid containing epithelial cells distils from the orifice, or can be expressed from it. This discharge is occasionally puriform, and may concrete so as to close the orifice and prevent the escape of the fluid. The narrow tract is lined with membrane which occasionally is highly sensitive, and a cord-like thickening may be traced backwards along its course. The discharge from these fistulæ is augmented by deglutition, especially of warm fluids, and even by mental excitement; and it is said that menstruation in some cases causes an increased flow of the fluids as well as irritation in the orifice of the fistula. Alimentary matters are not found to escape by the orifices. The direction of the fistula may be straight, or tortuous, and generally runs toward the great cornu of the hyoid bone. When incomplete the passage may be of various lengths, and occasionally portions of cartilage or even of bone may be found attached to it, being vestiges of the branchial arches. The direction of the fistula may in many cases be shown by the passage of a probe or small sound, but from the narrowness and irregularity of the passage, and the violent cough excited, this exploration may be impossible. The injection of colored or pungent fluid may occasionally succeed in proving the communication with the pharynx, while the laryngoscope may in some cases assist the investigation.

The true nature of these fistulous openings is thus shown by their not having been preceded by any local inflammation; by their position, size, and direction; by the appearance of the external orifices, and the hard cords running upwards therefrom towards the hyoid bone, as well as by the fluid which distils from them.

These fistulæ very rarely heal spontaneously. They seldom embarrass either deglutition or respiration to any serious degree, and, as a rule, they neither demand nor admit of treatment. Injections of tincture of iodine or of solutions of nitrate of silver, and the galvanic wire, have been tried, but there is risk of bringing about closure of the external orifice only, and so doing harm by inducing an accumulation of the secretion within. Incisions are useless unless the lining membrane of the track be entirely removed, and to attempt anything of this kind in such a situation, and for so trifling an affection, would be altogether unjustifiable.

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[1] See Virchow's Archiv, 1864 und 1865; also Pitha und Billroth's Handbuch, 1871; and Arch. Gén. de Méd., Janv. 1875.

2. Accidental or acquired fistulæ of the neck may be due to wounds, inflammatory action, the presence of dead bone or cartilage, etc. They may occupy any position, and involve any of the structures or organs of the neck. Pus, mucus, air, or alimentary matters, may escape from their orifices. In chronic disease of the larynx, when attended by necrosis of cartilage or bone, very troublesome fistulæ may form. Reference has, however, been already made in a previous part of this article to such affections. Suppurations of any kind in the neck, especially those connected with glands, bursæ, etc., may occasion the formation of fistulæ. The suppuration of a small serous bursal sac lying between the hyoid bone and thyroid cartilage, or of some of the small glands at the base of the tongue, may be the origin of a small but very troublesome fistula seated in front of the larynx. Injections of various kinds have been employed with but little effect, but when, which is seldom the case from the depth or direction of the fistula, it is possible to excise it along with its deep terminal extremity, its closure may be secured.

As a result of venereal ulcers, or of wounds made by the surgeon, or by accident, a small orifice may lead into the larynx or trachea. I had lately under my observation a patient in whom an opening large enough to admit the point of the little finger remained after a determined attempt at suicide, which removed a considerable portion of the cartilage. When such large fistulæ exist below the glottis, there is great risk of the upper part of the air-passage being in a great measure obliterated by contraction, and of the voice being lost. These fistulæ, unless very small, are difficult or impossible to close, and in cases where contraction has taken place above, it may not be safe to obliterate them, for fear of undue interference with respiration. Cauterization and plastic operations usually fail when the orifices are large. Many methods, however, have been tried. Nélaton employed two flaps adjusted in the same way as in his well-known operation for urethral fistulæ. Roux and Després have introduced other plans. Jamieson's suggestion has also been put into practice. This consists in rolling up and inserting into the pared orifice a narrow strip of tissue dissected from the neighborhood, and retaining its connection at one end. It is fixed by a needle or sutures.

Erichsen[1] describes a simple and useful method of operating: "The edges of the fistulous opening having been freely pared, and the knife passed under them for some distance so as to detach them from the subjacent parts, a vertical incision is made through the lower lip of the opening so as to split it downwards. Two points of suture are then inserted into each side of the horizontal incisions bringing their edges into contact, *but the vertical cut is left free* for discharges and mucus to drain through, and for the expired air to escape, lest emphysema occur. Unless this outlet is afforded, these fluids will burst through the sutures and destroy union of the edges."

Œsophageal fistulæ are very rare, and need not be considered.

Gunshot Wounds of the Neck.

Gunshot wounds of the neck are not very uncommon in war. The various campaigns which, in Europe, America, and India, have afforded extensive fields for observation within the last quarter of a century, have abundantly illustrated the pathology of these wounds, but have not added much to our knowledge regarding their management. In the records of these wars, now accessible to all, the facts are clearly set forth, but there is nothing which in this place specially calls for comment. Doubtless many of those who are wounded in the neck die of hemorrhage on the field, but many escape in a marvellous manner, and recover from injuries which at first appear hopeless. Any of the important structures may be hurt, the windpipe and œsophagus may be perforated or carried away, in part or to a wide extent, and one or more of the great nerves, which are here so numerous and important, may be destroyed or so bruised as to fail in their function. It is in the nerves of the upper extremity that this failure is most frequently seen after gunshot wounds, but it would be altogether beyond the scope of this article to do more than refer to these lesions.

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[1] Op. cit., vol. i. p. 422.

Sprains of the Neck.

Sprains of the neck causing pain on movement, especially when the head is drawn backwards, are not uncommon. It is perhaps in railway accidents that these injuries are most apt to occur. A passenger, sitting reading when a collision takes place, is thrown forward, against his opposite neighbor or on the side of the carriage, striking the crown of his head. The pain is in such cases not confined to the muscles and ligaments of the neck, but shoots into the arms, and may for a time occasion derangement or deficiency of sensation, and feebleness in motion. I have lately seen two such cases, within a few days of each other. One patient was hurt, as described, on a railway; the other was thrown on his head when hunting, his neck being bent. What was somewhat remarkable, was that the pain mostly complained of in each case was strictly confined to the distribution of the musculo-cutaneous nerve, and that it could always be aroused by bending the head on the chest, or pressing on the upper part of the neck. It did not disappear in either case for several weeks.

Sprains of the neck are to be treated by rest and fixation (sand-bags may be required), with fomentations, and afterwards anodyne embrocations. Cupping and blisters may be necessary to remove the after-effects.

Boils and Carbuncles.

The back of the neck is one of the common positions where *boils and carbuncles* appear. Occasionally they also occur on the sides and front. The pain which such affections cause when they invade the indistensible structures of the nape, is very great, and may, with the loss of sleep and want of appetite, produce dangerous weakness. Fatal results occasionally arise from blood poisoning, as the pus which forms gains ready access to the veins and sinuses of the brain; and the vertebral canal may be laid open by the destructive erosion of a carbuncle. Enormous phlegmonous masses are at times seen on the back of the neck, extending from ear to ear, and as they generally occur in persons who from habits or employment are in a depraved and depressed state of health (intemperate persons with hepatic and renal affections, especially), the danger to life is often very imminent. They demand early and decisive care, but their remedies are in all respects those used for similar affections in other regions, and which have been elsewhere described.

Cicatrices of the Neck.

Cicatrices may follow burns, wounds, abscesses, or ulcers of the neck, and require careful treatment on account of the unsightly appearance which they cause. It is not, however, the uncomely look of these contractions alone which calls for the surgeon's attention, but the displacement of parts and the embarrassment of function depending thereon demand to be remedied. It is chiefly after deep burns that these deformities are met with, and in such cases the most extensive displacement may take place, the chin being drawn towards the chest, or the head twisted or held firmly in some inconvenient or ungainly position. The power and long endurance of such contractions are well known. When the lower jaw is drawn down and fixed, and the lower lip everted, the gums exposed, and the tissues swelled and livid, a most distressing appearance is produced, and if it is established early in life, and not corrected, the development of the face is so interfered with that recovery becomes impossible. Excoriations arise from the irritation of the dribbling saliva, mastication and deglutition are impaired, and even phonation and respiration are seriously hindered.

These cicatrices vary much in extent and depth, as also in color and arrangement. They may be extensively adherent, or may be attached at their ends only. They may vary in color, from white to red, or brown. Bands or cords of great firmness and tenacity, projecting more or less from the surface, and having deep hollows between, run in different directions and produce a very repulsive effect. If ulceration takes place, it is difficult or impossible to heal it.

The *treatment* of these cicatrices is always difficult, and often most unsatisfactory. Mechanical appliances, together with a careful attention to position, will achieve much during the consolidation of the cicatrization, but they are apt to be discontinued, or only carelessly applied, before that process is complete and the contractile force exhausted. By successive grafts of new skin, the healing area may be much diminished and the suppleness of the tissues increased. The healing is thus not only expedited, but the repairing tissue is rendered much more flexible and abundant, and so more capable of being stretched—a capability which should be taken full advantage of as long as the due closure of the wound is not arrested. No operation need be attempted while the contraction is active, and it is far from easy to decide when best to interfere, as each case presents special features which require consideration. When old, inodular tissue does not readily allow of meddling; it is apt to have firm and insoluble connections established, and the deformity is often great and incapable of rectification.

To allow of stretching the tissue, incisions of various kinds are employed, while to diminish its thickness and resistance, compression, and agents which are supposed to promote absorption, have been used. To get altogether rid of the objectionable material, its removal has been effected by caustics or by excision, followed by simple re-union of the bordering healthy tissues, or by replacing by a plastic operation what has been taken away.

The treatment by incision is seldom adequate to the requirements of these cases, and it is not easily applied in an effective way in the neck. Though carried out with ingenuity and skill, it has often failed. Sometimes open incisions have been made; sometimes subcutaneous; occasionally the bands have been merely divided, and at other times they have been dissected up from the parts below. Multiple, small incisions, and extensive and deep ones, have all been tried. They have been made across the bands, or in zigzag, and all that mechanical skill could suggest in the way of apparatus, to keep up extension afterwards, has been used, but in nine cases out of ten they have only led to disappointment by their inadequacy to counteract the contraction, or by the irritation, inflammation, and ulceration which the subsequent extension has induced.

When the cicatrix is limited in extent, lies in the line of the superficial muscles, and is set in supple tissue, perhaps the most satisfactory way is to remove it entirely and unite the wound carefully by suture, taking every advantage of plaits of skin, shadows of surface, etc. A straight, linear cicatrix may thus be substituted for a raised, rough, and deformed band. In other cases the replacement of the objectionable tissue by a plastic operation is the happiest resource. In removing the old tissue, such a line of incision should be employed as will best fit the adaptation of the proposed new flap. The bed in which the flap is to lie must be very carefully prepared, and all hard tissue removed from its surface and sides. The "method by sliding" (erroneously called "the French") is that most commonly employed. Flaps must be secured from one side or both, and that in varying proportions and shapes to suit the state of the parts and the ease of adjustment; and in the fashioning, fitting, and subsequent treatment of such parts, the well understood and widely practised principles of plastic surgery must be carefully applied. Flaps have been taken to replace cicatrices on the neck, from any and all the surrounding surfaces. Thus the face, front of chest, top of shoulder, and neck itself, have all been put under contribution. Carden and Teale in England, Mütter in America, Richet and Péan in France, have all published leading cases.[1]

The "Indian method," by replacement, can of course be combined with that by sliding, while incisions and skin-grafting may also help in securing the desired result. In cases of extensive deformity, part only of the surface involved should be dealt with at a time, so as not to run too much risk. Esmarch's operation for establishing a joint in the body of the bone may be called for, when the lower jaw is drawn down and fixed, and cannot be freed.

As to the use of compression, and of caustic applications, little need be said. Plates of lead, or special apparatus, have been used, in order to cause the absorption of the unduly prominent tissue, but to little purpose. Caustics and iodine cannot be used effectually without running great risk of setting up ulcerative action, and when that begins in cicatricial tissue, it is impossible to say where it will cease. I have secured very good results, in cases of slight or medium severity, by the prolonged use of colorless iodine, begun in small quantities, painted on once or twice a day with a camel's-hair brush, and desisted from on the appearance of any undue irritation. The strength and frequency of the application must be regulated by its effects, and it may have to be continued for months. I have seen no benefit in the way of improving the color, from the use of chlorine or other remedies.

TUMORS OF THE NECK.

These may be of many diverse kinds, and may present some most formidable features. Innocent or malignant in character; connected with or lying in contact with the important structures of this region; congenital or not in their origin; merely giving rise to discomfort or deformity, or rapidly menacing the life of the patient, they cannot fail to secure the attention and anxious care of the surgeon. Their superficial or deep position, and their relation to the deep cervical aponeurosis, are points of the utmost importance. Abscesses have been already spoken of. Adenoma, cystoma, angeioma, lipoma, sarcoma, fibroma, myxoma, enchondroma, osteoma, papilloma, lymphoma, neuroma, epithelioma, and carcinoma, in short almost all the fluid and solid growths we are acquainted with, may be met with in some of their forms in the region of the neck. Some of these are fortunately rare, and the consideration of them need not detain us, but others are common enough, and demand detailed description. The various glandular structures here present are frequent starting points of tumors, and especially of the more formidable sorts which in this position occasionally attain a very great size.

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[1] See Med. Times and Gazette, 1857; Brit. and For. Med.-Chir. Review, vol. xiv., and Union Médicale, 1868.

Pneumatocele and emphysema of the cellular tissue may be passed lightly by. A pneumatocele is capable of being emptied by pressure, but reappears on forced expiration. It forms a circumscribed tumor, increasing and diminishing with the respiration. It is resonant on percussion, and soft on palpation. The lung may also be projected into the lower part of the neck so as to form a hernia. This is a very rare condition, and is irremediable.

In examining a growth of the neck, it is most desirable to determine its relationship to the deep fascia. The information thus secured will help materially to distinguish the nature of the tumor, its future effects, and the hope of removing it When placed below that strong and firmly bound down membrane, it will as it grows induce symptoms which are very manifest and important. The consistence of such deeply placed tumors is augmented, their outline is less clear, the fingers cannot be passed under them, nor can they be raised up and isolated. The pressure which they occasion will early begin to tell, and the pressure-effects will be out of proportion to their apparent size. The influence too of the fascia will be observed in the fixed character of the growths. Any or all the organs in the neck may suffer from the pressure of a deep growth. The air-passages, the pharynx and œsophagus, the great bloodvessels, and the nerves—including the sympathetic, the recurrent, and the pneumogastric—may be thus affected. The well-known effects on the temperature and cutaneous sensibility of the face and ear, and the changes in the conjunctiva and pupil, which indicate compression of the sympathetic,[1] may be observed. The circulation through the brain too may suffer, and, in short, most serious and wide-spread effects may follow from the pressure exercised on important organs. The observation of Vidal, that the violence of the pressure in deep tumors may subside as the growth progresses, has not been verified in my own experience, though the fact that it is only in the later stages of superficial tumors—that is, when they have reached considerable dimensions—that the evidence of pressure may appear, is in keeping with what would naturally be expected.

Aneurism, spina bifida, and ranula do not lie within the range of this article, but adenitis, lymphoma, cystoma, lipoma, fibroma, enchondroma, and carcinoma will be considered, while various growths of less frequency or importance will be very shortly alluded to.

Adenitis and Adenoma.—Acute inflammation of the glands has been already described. The chronic form is both common and difficult to deal with, and that chiefly from the circumstance that it may be dependent on either a local or a constitutional cause, or on both, acting in varying degrees. The subacute form of the affection is also frequently met with after depressing ailments. Irritation in some part of that enormous surface whose lymphatic vessels end in the cervical glands, is the usual, if not (as some believe) the sole cause of that enlargement which characterizes chronic adenitis. Upon the violence or acuteness of that irritation will of course greatly depend what the effect on the gland will be, whether it shall be excited to acute action, or shall slowly and painlessly increase by hypertrophy. The surfaces of the head, outside and within its various cavities, are frequently the seat of such lesions as would create the irritation required, but behind this, and giving it emphasis and force, we too often have a constitutional or general predisposition, or diathesis, which promotes and augments the pernicious effects. It is in the young and those of feeble constitution that glandular enlargements are most common, and it is not infrequent to find them present in various members of the same family. A temporary derangement of the health, due to unaccustomed strain on mind or body, may cause this malady to appear very quickly, and the best barrier which can be raised to its progress is to recognize and remove the depressing cause.

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[1] Porteau, Des lésions de la portion cervicale du grand sympathétique. Paris, 1869.

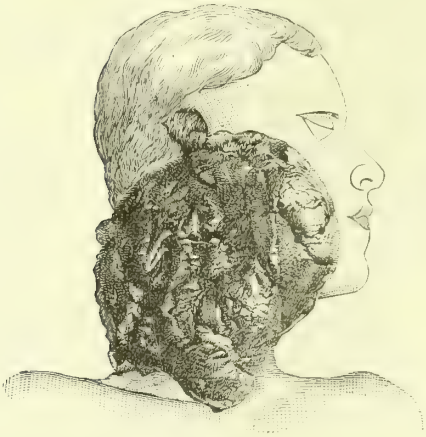
In constitutional syphilis, we frequently meet with small, hard, rolling, and painless glands in the back of the neck, and sometimes along the edge of the trapezius; but in neither position are they as constant or as characteristic as was at one time supposed.

In size, shape, consistence, and number of glands involved, there is much variety in adenitis of the neck. Its dimensions range from that of a pea, to that of a mass as big as the fist, and it may be round, oval, or irregular in shape, from the fusing or matting together of several glands. Its consistence varies from that of flesh to that of bone, and as regards number, while occasionally, but rarely, single glands are inflamed, they are more commonly met with in groups or chains, sometimes filling the whole side of the neck. If chronic, they are painless, and are slow to suppurate or break down, while long periods may pass with but little perceptible change in their size or connections. If from any cause more violent action arises in them, not only may the gland be destroyed, but the surrounding cellular tissue and overlying skin may partake in the inflammation, and, if pus works its way to the surface, sinuses may remain to mark the point of its passage. If the whole of the diseased tissue is expelled, these openings may close, and leave deep and indelible marks. If large and hard, and placed near compressible structures, these glandular enlargements may exert injurious pressure. Bloodvessels and nerves may thus suffer, as we see when the axilla is filled by glandular masses causing the violent pains and œdema in the arm which produce so much distress in carcinoma.

Caseous degeneration is a not uncommon affection of unhealthy youth, and is generally wide-spread in its ravages, attacking many glands contemporaneously or in succession. These glands are liable to suppurate, but not always in a distinct and satisfactory manner. Part of the gland may break down, while the stool or basis remains behind to feed the suppuration and delay the recovery. Early and efficient opening with antiseptic precautions, with, it may be, the free use of the spoon to remove the *débris* of the gland, is the most essential point in the local treatment. It is far from easy to avoid leaving disagreeable marks after such proceedings, but the surgeon's interference, if judicious and well directed, will produce less destruction, and leave less objectionable traces, than spontaneous evacuation of the pus.

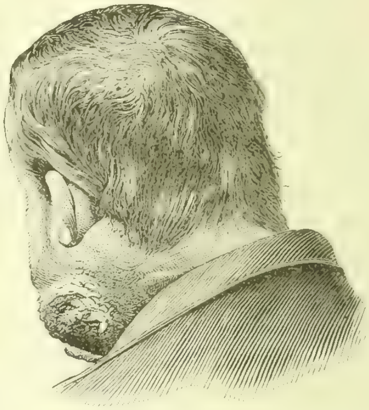
When the glands of the neck become enlarged from malignant disease, they grow quickly, and produce early and disastrous pressure-effects, causing shooting pains along the nerves, interference with the blood supply, displacement of the soft structures, and implication of the skin leading to ulceration. The general health becomes involved, and thus from a combination of symptoms the true nature of the growth is recognized. It is secondarily to other cancerous deposits existing on the line of the lymphatic vessels converging to the glands in the mouth, throat, larynx, etc., that the disease appears. Primary cancer is extremely rare in these glands. When it occurs, many glands will be affected in succession, and soon such a condition will be established as to be beyond surgical aid. It is by the hardness and fixation of these masses, the pain in the nerves compressed, the early matting together of the growth and its close adhesion to the parts around it, the implication of the overlying skin and rapid deterioration of the health, that true cancer in these glands is distinguished from lympho-sarcoma and other tumors. The photograph here copied (Fig. 1014) was taken from a cast made from a case of malignant disease after death. It shows the terrible destruction which such an affection may occasion before death relieves the sufferer. The other (Fig. 1015) was taken shortly before death from a patient under my care, in whom the nature of the affection was recognized when the growth was a small, hard, deep-set tumor, only four months before it attained the size represented.

Fig. 1014.



Malignant tumor of neck.

Fig. 1015.



Malignant tumor of neck.

LYMPHOMA has attracted much attention of late years. It is not uncommon in the neck, and is difficult or impossible to distinguish, in its early stages, from mere hypertrophy of glands. In minute structure this tumor resembles lymphatic-gland tissue, but its constituents vary considerably in different examples, the cells and the containing basis-fibre bearing different proportions to one another, and so causing the consistency of these tumors to differ.

When the cell-elements greatly predominate, the growth is not only less coherent and softer, but it becomes very malignant, infecting neighboring structures, and many and distant parts, contaminating the whole system, causing a general and characteristic anæmia, and killing miserably. This general form, this "lymphoid cancer" as it has been termed, is chiefly known in England as "Hodgkin's Disease,"[1] and abroad as lympho-sarcoma (Virchow) and lymphadenoma (Cornil and Ranvier).

The simple or local form may involve one gland or many, and may be confined to the neck. It may attain a great size, and occasion considerable pressure. It is firm, fleshy, movable, indolent, and loosely set in the part, and the skin over it is unchanged. This growth may begin on one side of the neck, most frequently at the angle of the jaw, or by the edge of the sterno-mastoid. It may progress very slowly, and may even remain stationary for a time.

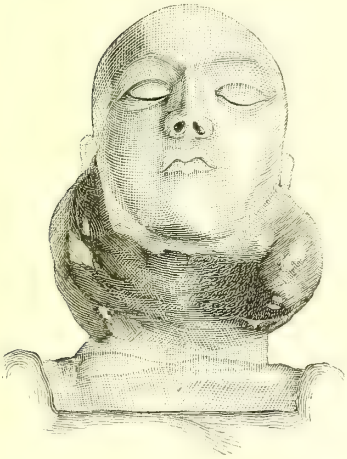
[1] See Medico-Chir. Trans., vol. xvii. 1832.

Many masses may be adherent to one another, but they are readily shelled out when the overlying parts are divided.

In the general form of the affection, there will appear in other regions, as the armpit, groins, etc., similar growths to that present in the neck, while the spleen, liver, and other organs, may also present tumors of like structure. When the blood has become so altered in composition as to present a great excess of white corpuscles, then we have that "leucocythæmia" established which makes its presence so evident in the complexion. It is beyond our present art to differentiate the two forms of lymphoma where the growths are small and undeveloped, and even to distinguish them from chronic adenitis, can at times be but a happy guess. When the rapid growth, soft consistence, multiplicity, bossy contour, freedom from pain, and absence of all scrofulous taint, become apparent, then the idea of mere adenitis drops out of view, and, as the affection quickly progresses and shows itself in various parts, either internally or externally, and the general system begins to suffer, then the diagnosis of the special form of lymphoma present can no longer be doubted. In "white-blood" disease, an examination of the blood will of course demonstrate its condition. It is on the clinical history that our chief reliance must be placed, for though various instruments have been invented for securing a minute portion of the tumor for microscopic examination, such an examination could not furnish confidence in forming a judgment.

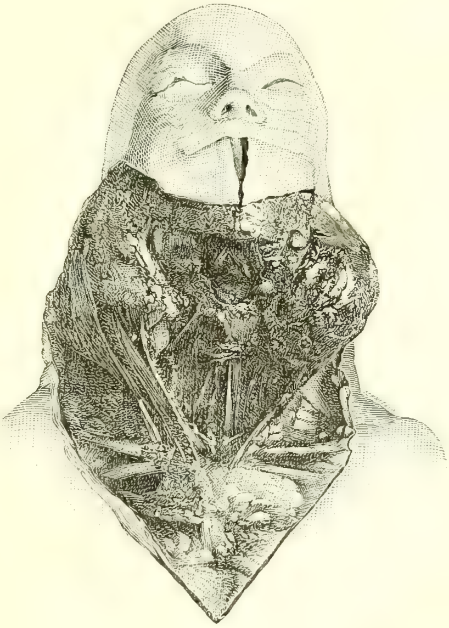
The photograph here copied (Fig. 1016) was taken from a cast in my possession, and is historically interesting, as it is one of those which were made by Mr. Allan Burns, when studying the subject of the anatomy of the head and neck, for his well-known work; and the next (Fig. 1017) appears to have been taken from a dissection of the same. Fig. 1018 represents like

Fig. 1016.



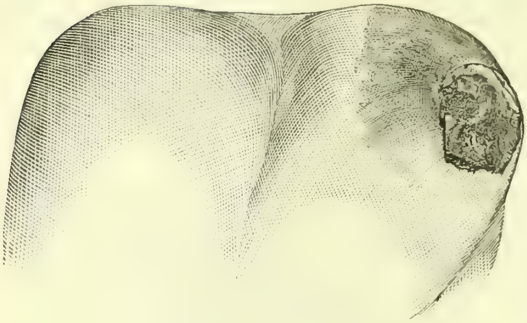
Lymphoma of the neck.
(From a cast by Allan Burns.)

Fig. 1017.



Lymphoma of the neck. Dissection of the parts seen in Fig. 1016.

Fig. 1018.



Lymphoma of the neck.

them a case of lymphoma which was under my care, and in which the tumor occupied the clavicular region.

Papillary growths are met with in the neck in both the simple and epithelial forms of warts, but they do not demand detailed notice.

Nævi are not unusual in the neck, and may be either arterial, venous, or mixed, cutaneous or subcutaneous, etc., as in other parts, but there is nothing in their nature, progress, or management, special or peculiar, derived from the region in which they occur. I have twice had occasion to excise deep arterial nævi lying on and implicating the sterno-mastoid muscle. In the first case, the growth, before being cut upon, had all the physical characters of a glandular tumor, and, as it was enlarging and causing deformity, the patient (a female) wished it removed. There was no pulsation observed till the soft parts were divided, and it was prominent and firm. It bled very freely indeed when touched with the knife, and it had to have needles placed under it, and a twisted suture applied, before the bleeding could be arrested. When the true nature of the tumor was recognized, it was removed along with an inch and a quarter of the muscle which was involved. This patient died of septicæmia in ten days. In the second case the tumor had been cut into in the country, and the patient was sent to me in Glasgow, with many pins and ligatures in position, which had been applied to command the serious bleeding that had taken place. In this case the tumor was successfully excised along with all the affected muscle. In both cases the nævoid nature of the tumor was recognized after removal.

It is always to be remembered that venous and mixed nævi usually disappear spontaneously after teething is over, and that injections should never be used in dealing with these affections on the head or neck, from the danger, which is very real and imminent, of causing thrombosis. Excision is by far the best mode of dealing with nævi here and elsewhere, when it can be employed, but the ligature, cauterization, electrolysis, etc., may in some cases be preferred.

Lipoma is sometimes met with in the neck, and may attain a very great size, growing slowly and painlessly, and only occasioning harm by its mechanical effects. Such a growth may affect even a young child, and may appear for the first time soon after birth. No part of the neck is exempt from these tumors, but it is on the posterior aspect that they have been most usually seen. Liston refers to several examples of large fatty growth in the neck, and medical literature is rich in such cases; in many instances very large tumors of this kind have been successfully removed.[1] Their physical characters are all well known. They may be sessile or pedunculated, doughy to the hand, and occasionally so soft as to appear fluctuating. They may be in rare cases symmetrical, and they may, it is said, occasionally cause the skin to ulcerate over them. They are movable, grow slowly, are painless, and have the superficial veins sometimes enlarged and prominent. Long prolongations may pass deeply from these tumors among the muscles, and even around the bloodvessels, giving but slight indication of their existence as the movability of the growth is thereby little affected; but, as a general rule, lipomata do not dip beyond the subcutaneous cellular tissue. When the skin over them is rendered tense, the line of attachment of the interlobular partitions will be seen, and this is distinctive. The hardening effects of ether, which has been used to differentiate fatty growths from others, is quite unreliable as a diagnostic test.

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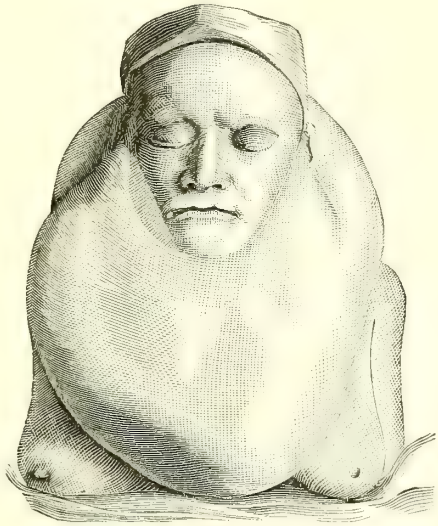
[1] See Trans. Pathol. Soc. of London (especially for 1860); also Indian Med. Gaz. 1874.

Fig. 1019.



Large lipoma of neck.

FIBROMA, ENCHONDROMA, AND OSTEOMA are unusual tumors in the neck, but in connection with the ligamentum nuchæ, or the vertebral periosteum, we may have the two former, while enchondroma may also be met with in the parotid and submaxillary glands, and exostoses occasionally grow from the transverse processes of the vertebræ. Fibrous and cartilaginous tumors, as a rule, grow slowly, are smooth or lobed, and in consistence vary from being elastic to being stony hard. They may attain a great size, are often quite movable and free from pain, and are covered by unchanged skin; they may too, as may more especially the exostoses, give rise to much suffering by their pressure on nerves, and may interfere greatly with the circulation in both arteries and veins.[1]

NEUROMATA, both single and multiple, have been recognized in connection with the fifth, sixth, and seventh cervical nerves. They have been observed most usually on the pneumogastric, but the sympathetic and phrenic also have both been found so affected.[2]

SYPHILITIC GUMMATA may appear in the glands and subcutaneous tissue of the neck, and also in the sterno-mastoid muscle. They may soften, suppurate, and discharge, leaving fistulæ. The sterno-mastoid is also occasionally the seat of chronic inflammation of a syphilitic nature, and of a curious hardening which goes by the name of "myo-sclerosis." When affected with chronic inflammation (in the secondary or tertiary stage of the disease), there are tenderness, stiffness, and irregular swelling in the muscle, and the pain is increased by motion of the part.[3] The external and internal use of iodine is the best remedy for this condition.

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[1] Trélat, Gazette des Hôpitaux. 1868.

[2] Accounts will be found of such growths in the well-known monograph of Professor R. W. Smith, of Dublin; in Langenbeck's Archiv, Bd. iii.; in Mém. de la Soc. de Chir., tome iii.; in Pathol. Trans., vol. viii.; and in Comptes Rendus de l'Acad. des Sciences, 1845.

[3] Bouisson, Gaz. Méd. de Paris. Juillet, 1856.

MYO-SCLEROSIS. (*Congenital Induration or Tumor of the Sterno-Mastoid.*)—As to *myo-sclerosis*, it appears a few days, or at most weeks, after birth, and appears to be due to inflammatory exudation. Part only of the muscle may be involved, or the whole of its extent may become hard like bone, and swelled so as to present a very noticeable condition. It is always unilateral, and has its seat in the sheath of the muscle. The skin is not involved, and pain may be occasioned when the muscle is compressed or put in action. In the last case which fell under my observation, all movement of the head appeared to produce much uneasiness. No explanation quite adequate to account for this curious affection has yet been found. Strains during delivery, or the pressure of the forceps, may in some instances account for it; but it has also been observed in cases in which the child has been born without any difficulty whatever. No hereditary or constitutional state has been so commonly associated with this affection as to establish the existence of any connection with it. The spontaneous disappearance of this condition after some months—from two to six on an average—and the restoration of the muscle to its normal state, may be expected with confidence; if any interference were thought of, it would probably take the form of friction, or possibly gentle counter-irritation—but these measures are really unnecessary.

LYMPH-ANGEIOMA is a name given to a rare tumor formed of capillary lymphatic vessels, which has been said to occur in the neck and to attain a considerable size. Nothing is known of its etiology or clinical characters that is reliable or worthy of remark.

Solid growths of the neck, especially glandular tumors, occasionally derive a more or less distinct pulsation from contact with, or adhesion to, the carotid artery. If the tumor surround the artery, as it has been found to do, then the deception is complete, as the pulsation appears excentric and expansive. It will be chiefly by careful inquiry into the clinical history of the case, by noting its progress, the consistency and outline of the tumor, the possibility or not of pushing it aside and so arresting the pulsation, and at the same time of defining the outline of the growth and the position of the artery below, and finally by observing the probable existence of other similar tumors when the disease is glandular, that the diagnosis is arrived at.

As to the treatment of these various tumors, it will be best given in the order in which they have been spoken of.

Treatment of Cervical Tumors.—*Chronic adenitis* will demand, in the first place, the correction of the cause, constitutional or local, on which it depends, if that can be found, and is capable of being dealt with. In many cases the digestion is deranged and the system lowered. The assimilating organs will require careful attention, and their vigor must be maintained or improved; then iron, iodine, phosphorus, and cod-liver oil may be given in some of the many combinations which have of late years so much simplified the administration and increased the usefulness of these remedies. The hygienic surroundings of the patient—his dress and exercise, his food and air supply, the action of his skin, etc.—will profitably engage the surgeon's attention and supervision. Sea-air has a well-established reputation in these cases, especially when the scrofulous diathesis is present. If there is any suspicion of syphilis, that will supply an important hint to guide the treatment. If inflammation should arise in the glands, fomentations, and it may be one or two leeches applied close to the affected part, will be serviceable, but cold is not to be commended. Counter-irritation by colorless iodine, or by a lotion containing iodine with iodide of potassium and a little spirit, or by the various ointments into whose composition iodine enters, is, if properly regulated, most useful in the subacute and chronic stages of simple adenitis, but it is very liable to abuse and overuse, and must be supervised. The employment of more powerful local applications, such as cantharides, tartar emetic, croton oil, or mercury, is hazardous, because of the risk of inducing too violent action. Belladonna, too, to relieve pain, is rarely required, and in young persons may occasion annoying symptoms. If suppuration occur, the pus cannot be too early evacuated, and this should be done by a clean cut with antiseptic precautions. That is better than the use of the aspirator, seton, etc., which rarely fulfil the end in view, and may irritate and do harm. Such puerilities as applying the iodine, not to the gland, but to the part (mouth, nose, etc.) from which its lymphatic vessels are derived, need hardly be mentioned.

Shampooing, compression, crushing, acupuncture, and galvanism, either in the form of galvano-puncture or of the continuous current, have all their advocates in dealing with hypertrophy of cervical glands. Shampooing is very liable to be overdone, and so set up inflammation. Pressure cannot well be applied in the neck, except, perhaps, in the parotid and mastoid regions, where there is bone behind; but special forms of apparatus have been invented for its employment. Compresses of metal, wood, bone, agaric, charpie, etc., have been applied, and expensive and elaborate instruments have been constructed, but their success has been small, and occasionally the harm caused has been considerable. Crushing alone, or combined with subcutaneous division by a cataract-needle, has too often been attended with diffuse inflammation and suppuration. Mere manipulation has been used as a step preparatory to excision, "in order to render the gland more movable." "Ignipuncture," or the introduction of a pointed, red-hot iron into the middle of the mass, or the placing there some of Maisonneuve's chloride-of-zinc pencils ("flêches"), have both been fairly tried, but with very indifferent success. Such applications are very painful, very violent, and attended with marked danger in deep and large tumors, and they leave serious scars.

Electrolysis is slow, troublesome, and generally unsatisfactory, but there are cases on record in which considerable masses of scrofulous glands have been dissipated by perseverance in its use.[1] Interstitial injections of many kinds have been tried. Various solutions of iodine, nitrate of silver, chloride of zinc, salts of sodium, alcohol, perchloride of iron, and carbolic acid, and Fowler's solution of arsenic, have been employed. In most cases the aim has been to set up suppuration, and so to break down the mass; but iodine, when so introduced, in the simple, chronic form of adenitis in healthy persons, is undoubtedly a valuable remedy. It causes absorption, with but little disturbance, if used in small and repeated quantities, passed by means of a small hypodermic syringe deeply into the tumor, after the surface has been rendered insensible by the ether-spray. In scrofulous subjects, it is apt to be followed by suppuration and local disaster. Injections of solutions of chloride of zinc have, however, even in scrofulous cases, occasionally answered well. The excision of hypertrophied glands has been often practised. In simple chronic adenitis, and in scrofulous enlargements, it is quite justifiable when other measures of less violence have failed, unless in children and young persons, for whom time and improved hygienic conditions may be expected to do much. It is, perhaps, in healthy females—in whom local and general remedies have failed, and who suffer from superficial, distinct, chronic, and movable growths, which occasion deformity and annoying pressure—that excision is most justifiable. The position, size, connections, etc., of the tumor, must guide the surgeon in determining his conduct, together with the clear conviction that less severe measures have been exhausted, and that the case is such as to demand such a step being carried out. No doubt the use of antiseptics has greatly diminished the risk of such operations, and the mark left may, by a careful planning of the line to be followed, together with the rapid union which antiseptic surgery insures, be very insignificant. The propriety of getting rid of scrofulous collections is now well understood, and contrasts with the old fear of such interference causing outbreaks elsewhere.

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[1] Golding-Bird, Lancet, 1877.

The treatment of *carcinoma* in the neck is, as might be expected, most unsatisfactory. Generally it is quite beyond the surgeon's aid. It cannot, as a rule, be completely excised from the connections which it has formed by the time its true nature is recognized, and as the tumors are usually secondary to other, like growths elsewhere—which are often still more inaccessible—it would be of little use to remove them. Interstitial injections are highly dangerous in such growths, and chloride-of-zinc arrows are of very limited application in this region of the body.

Lymphoma.—The treatment of this disease in any form is confessedly very difficult and unsatisfactory. All irritating applications tend to make these tumors increase with enhanced speed, and electricity has proved quite useless. When the growths are part of a general affection (*lympho-sarcoma*), no remedy is of any value, and interference is to be declined, though arsenic and phosphorus, when injected into the tumor or given internally, so as to develop their poisonous effects, have been said, on reliable authority, occasionally to arrest the progress of the disease. These favorable results, however, have too rarely been secured to make the risk of their employment quite justifiable. Arsenic in particular, when used by interstitial injection, occasions most violent effects, difficult, or impossible, to regulate or command; and there seems good reason to suppose that any influence which the drugs named have in retarding the growth of the tumor, is only due to the general depression which they bring about in the nutrient functions—an effect equally seen after attacks of acute rheumatism and erysipelas. From the loose connection of lymphoma, it is easy to shell it out before it has attained a great size; but if the constitution be involved, a rapid recurrence will take place. If the larynx or trachea be seriously compressed, it may be necessary to open the windpipe.

An observation of Duplay is worthy of record, though its clinical use has not been found great. It is this, that if a tumor of the nature now under consideration increases in the direction of the lymphatic vessels, that is, downwards towards the chest, the worst opinion may be formed of its nature; but if, on the contrary, it grows in the contrary direction, that is, against the flow of the lymph, a more favorable prognosis may be formed.

When similar growths occur in other regions of the body, all interference is of course plainly unjustifiable.

Fatty, fibrous, and cartilaginous tumors can only be excised, if they are interfered with at all. If they are increasing, the sooner such a step is taken the better. A deep dissection will, in all likelihood, be required to effect the removal of fibroma and enchondroma, and no small difficulty may attend the separation of their deep connections. So great has been the intricacy of their relations in not a few recorded cases, that it has been found necessary to remove them piece by piece. The risk of wounding the veins is especially great.

The treatment of *venous or mixed nævi* of the neck differs in no way from their management elsewhere, except that coagulant injections are here very dangerous, from the risk of clots being carried into the blood stream. Arterial nævi are best excised or strangulated by passing needles under them and applying the twisted suture. Electrolysis, cauterization, and the ligature have all been applied to nævi of the neck.

Syphilitic tumors are to be dealt with through the general system, according to the stage of the disease in which they arise. Iodide of potassium and iron in large doses are, as a rule, the most efficacious treatment, with possibly the careful administration of the green iodide of mercury in the event of the other remedies failing, or being slow to act. Iodine may also be applied locally.[1]

CYSTS OF THE NECK.

There are many forms of cystoma met with in this region. Some of these tumors lie above and some below the cervical aponeurosis. Some are solitary, and others are found in groups forming large and formidable tumors.[2]

CONGENITAL SEROUS CYSTS (*hydrocele of the neck; hygroma*) have their seat in the subcutaneous cellular tissue, and are chiefly seen on the left side of the neck in its antero-lateral region. They are usually unilocular, but are at times divided into various compartments by imperfect partitions. They are, for the most part, round, smooth, elastic swellings, having but a loose connection to the parts above and below them. If very tense, they may communicate to the hand the firmness of a solid growth. It is seldom that they are sufficiently prominent to enable translucency to be made out, but a certain bluish or opaline color can be sometimes distinguished. They cause no pain, but as they may attain an enormous size, so as even to fill the whole side of the neck, their bulk and the deformity which they occasion may cause much inconvenience. The contents may vary much in color and consistence, being at times like water, and at other times thick, and of a yellow, green, or dark-brown color, from mixture with blood. More rarely there are solid contents. The fluid is saline and albuminous, and if there are several cysts combined, each may have a different colored fluid within it. The cyst wall is usually very thin and delicate, so as to be difficult to recognize and remove; but in consequence of inflammatory deposition it may become thick and resistant. These cysts are not vascular, and the skin covering them may be healthy and unchanged. They do not, as a rule, cause functional disturbance; but in young children, when they attain a large size and are deeply placed, they may occasion a dangerous amount of pressure. If injured and consequently inflamed, or if bleeding take place into them, a serous cyst may become a source of danger. The least dangerous position for serous cysts (though they may cause much deformity when placed there) is the back of the neck, where they may reach a large size. When a number of cysts are combined in a congeries, the grouping may vary considerably, as secondary growths may be attached to the main mass and give it a very irregular shape. Congenital cysts occasionally undergo spontaneous cure. They may burst inwards into the pharynx, or outwards by the skin. They may become consolidated after inflammation, and may then disappear by absorption.

CYSTS CONTAINING TEETH, HAIR, CARTILAGE, ETC., have in rare instances been seen as congenital growths in the neck. They are soft, round, smooth and indolent, and often deeply placed and firmly connected. If they are opened or burst, they give rise to very troublesome fistulous openings.

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[1] Bouisson, Gaz. Méd. de Paris. Juillet, 1856.

[2] On this subject see Voillemier, Dee kystes du cou. Paris, 1851; Boucher, Étude sur les kystes congenitaux du cou. Paris, 1868; Maunoir, Mémoire. Paris, 1825; Hawkins, Med.-Chir. Trans. 1839; Bryant, Med. Times and Gazette. April, 1876; Anger, Bull. de la Soc. de Chirurgie. Déc. 1875; Vernher, Die angebornen Kystenhygrom; also many papers in Langenbeck's Arch. für klin. Chir., in the English Med. Journals, in the Gazette des Hôpitaux, Arch. Gén. de Médecine, etc.

COMPOUND CONGENITAL CYSTS.—The compound congenital cyst, from the deep position which it may occupy among the muscles (going even behind the pharynx and œsophagus), and from its close relation to important structures, is often a very formidable affair. It may be made up of many separate masses, or the growth may appear to be lobed, from being bound across by muscular or cellular bands, or by the partial or complete division of the cyst by partitions within. These cysts occur on the back of the neck, and not unfrequently in front, to the inner side of the sterno-mastoid. These growths have been seen at birth of a size to impede delivery. They have not only covered the whole side of the neck, but have hung down in front of the chest, and by their pressure on the floor of the mouth have occasioned serious difficulty in both breathing and swallowing. Various vices of conformation may be found to accompany them—conditions not connected with simple congenital cysts. Their contents are very much varied (glandular, sarcomatous, cartilaginous, colloid, and sanguineous elements), and their walls are not unusually hard and thick from calcareous, cartilaginous, or bony deposit, or from having undergone sarcomatous or other change. From the nature of their contents and the alterations in their walls, these cysts are firmer and more irregular in outline than simple cysts. Their consistence may vary greatly in different parts of their surface, being soft and fluctuating at one part, and hard as bone at others. There is little or no pain, and no pulsation, but the veins on their surface may be enlarged. They may burst and disappear, but at other times this occurrence has led to the breaking up of the patient's health.

NON-CONGENITAL CYSTS are sufficiently common.

The *sebaceous cyst* occurs here as elsewhere, and presents its usual, well-known characters. When deeply placed, as it occasionally is, it is difficult to be certain of its true nature before puncturing it.

The *sanguineous cyst* occurs mostly in young children, and appears to be due to bleeding into a serous cyst. The blood may be at rest within the cavity, or there may be a direct connection with a vein which allows of its circulation through the interior of the cyst.

Hydatid cysts are very rare, and their real nature may not be known till they are punctured. They may lie superficially, or they may be placed deeply among the muscles, especially on the back of the neck.

Symptoms of Non-congenital Cysts of the Neck.—Non-congenital cysts in adults grow slowly as a rule, and remain long stationary, and often attract little attention till they have attained a considerable size. If they are affected by inflammation, their rate of progress may be greatly accelerated, and they may become what otherwise they are not, painful. These cysts, however, occasionally make a rapid start in growth without any apparent cause. If small, they may appear to be solid from their tenseness, but if large, their soft consistence is commonly evident. No help is got in their examination from transparence. The skin covering them is not involved, and they are as a rule movable, smooth, and without pulsation or *bruit*, unless it be merely a heaving when they are in contact with the carotid. It is said that Mr. Syme on one occasion ligatured the common carotid for a supposed aneurism, when in reality it was a thick-walled cyst adherent to the vessel's side. The kind of movement, and the effects on the tumor of arresting the current of blood by pressure applied at the root of the neck, will, with the history, best aid the surgeon to avoid a like error.

The non-congenital cysts of the neck occur most frequently in connection with the glands of that region, though they may grow in the cellular tissue without any relation to the glandular structures. When situated in front of the neck, such a cyst may be confounded with goitre, which it may closely resemble in physical characters; but if a clear clinical history is obtainable, the distinction can be made, seeing that the goitre springs from a different part of the neck, and that it is only in their later stages that they come to coincide in position, and that, as a rule, the goitre is firmer, and has a movement with deglutition, and often, also, an effect on respiration, which is not observed in the case of a cyst unconnected with the thyroid body.

Diagnosis.—From spina-bifida and encephalocele, a cyst of the neck is differentiated (in those cases in which its position might cause the question to arise) by being more superficial, by having no connection with or influence upon the spinal cord or the brain, even when compressed, by exhibiting no movement on expiration and no pulsation, by not being reducible or pedunculated, and by there being no aperture in the parts below, such as may be frequently detected in hernia of the membranes of the cord or brain.

In many instances it is impossible to distinguish a cyst composed of a single cell, from one having many compartments. If the wave of fluid caused by percussion is found to be circumscribed, and if various distinct centres of movement are made out in a tumor, then its multilocular character cannot be doubted; but it is by no means the case that this is usually recognized in a satisfactory manner, and that because of the varying thickness of the cyst-walls and contents. In small cysts, even fluctuation may, from such causes, be very obscure and difficult to define. An exploratory puncture may be necessary to discover what is contained in such a cyst, but a consideration of the age of the patient, and the shape and history of the tumor, will supply important aids to diagnosis.

As to *prognosis*, it will, of course, turn on the nature, position, size, and connections of the cyst, and on the age of the patient. When large and deeply placed, in young children, the cysts will manifestly prove very dangerous. The multilocular cysts are worse than the unilocular, as they attain a greater size and are more difficult to deal with.

The *etiology* of cysts of the neck is very obscure, and as yet little understood. They have been ascribed to many causes, some of them not a little fanciful—injury received during pregnancy, undue uterine contractions, pressure from the umbilical cord, etc. That sanguineous cysts may arise from contusions or strains during delivery, has more probability to commend it. The various cysts have been traced by different observers to the bloodvessels, glands, and cellular tissue, and have been ascribed to imperfect development of structure, and to the uncertain realm of "new formations;" but notwithstanding the ample discussion which this point has undergone, little reliable light has yet been thrown upon it, and consequently it would be fruitless to dwell upon it further.[1]

No hereditary history can, as a rule, be traced regarding the occurrence of these cysts, and nothing important or reliable is known with reference to the influence of sex, age, etc., in their production.

Treatment.—In very young children it is well to delay, if possible, all interference till the strength of body diminishes the danger. Repeated punctures, aided, if possible, by compression, may retard the progress of these cysts.

The plans which may be pursued in the treatment of cysts of the neck are numerous and diversified, in order to meet the requirements of the various conditions and forms of the affection. If the contents could be got rid of by absorption, it is manifest that much would be gained. If this cannot be accomplished, then the evacuation of the fluid, followed by the obliteration of the sac, would present itself as the least objectionable device, while its destruction by caustic, its incision, or its entire removal by excision, might be in certain conditions the most feasible or most promising mode of management.

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[1] Reference can be made to Lücke, Traité des Tumeurs; Pitha und Billroth's Handbuch der Chirurgie; Richard, Bulletin de la Soc. de Chir. 1851; Lawrence, Medical Times. 1850; Voillemier, Des kystes du cou. 1851; Comptes Rendus de la Société de Biologie. 1853, 1854; Giraldès, Bull. de la Soc. de Chir. 1859; Verneuil, Tumeur congénitale du cou. 1875.

Compression is difficult or impossible to apply in the neck, so as to be effective and endurable. Even elastic collodion, which seems well adapted to exercise a certain useful pressure, proves objectionable in young and tender children from the irritation which it causes. Counter-irritation by iodine or cantharides, and the use of mercury or muriate of ammonium in solution or ointment, cause too much irritation in the child, and so are productive of harm. It is seldom that any appreciable or abiding influence is thus exercised in inducing absorption. To puncture the cyst without attempting to obliterate the sac, can only be a temporary expedient, as the fluid is quickly re-formed. In sanguineous cysts, serious and even fatal bleeding has in a few cases followed simple puncture. A fine aspirator needle is the best instrument to employ, if puncture is to be tried. To excite adhesive inflammation in the sac, after it has been emptied, has been attempted by the use of electricity, injections, the seton, etc. From the first of these agents little good has been got, though it has been frequently tried, and in many ways. Of the various injections, iodine has commended itself most. If thrown into a bloodvessel, or employed in too concentrated a form, it will unquestionably be followed by mischief; but these errors are not likely to occur when their possibility is present to the surgeon's mind. The quantity used is generally equal to half the bulk of the fluid which has been in the first instance withdrawn. It is thrown in slowly, through a small canula, which has been carried a short way under the skin before entering the cyst, so as to diminish the risk of air being introduced. A previous puncture of the skin with a knife, allows the canula to be passed with less force and with more precision. No washing-out of the cyst, preparatory to the injection of the iodine, is requisite, but that fluid should be allowed to escape (without squeezing) after it has remained in the sac for a short time. This, at least, is a safe precaution to enforce on the first occasion, as we cannot be certain what degree of action will be set up, and it is not wished that it should be too great. It is also well to wait the full effects of each injection, before another is used, and to be guided thereby. If pressure could be afterwards applied, it would materially aid the injection. Heated wine, alcohol, perchloride of iron, chloride of zinc, etc., have also been used by injection, and occasionally most disastrous results have followed from excessive inflammation. Some practitioners desire to occasion so considerable an amount of inflammation as to produce suppuration, but it is difficult to restrain or guide such a complication. A seton is obnoxious from the undue irritation which it is apt to cause, and, in its usual form, from its obstructing rather than aiding drainage; but a small vulcanite tube, or carbolized catgut (which is capable of being absorbed), or horse-hair, might, when injection failed, be thought of. The interior of the sac may be washed out, through a drainage-tube, with Condy's fluid, or with one of the unirritating antiseptic agents now in use. It is difficult to apply injections to the interior of multilocular growths. Jules Roux's suggestion, first to break down the partitions between the cysts, is more specious than practical.

To destroy a cyst of the neck by the application to its external surface of caustic in any form, can hardly be advocated, as such a method is not only slow, violent, painful, and uncertain, but leaves a most objectionable scar behind. A mark must also result from incision, but it need not be great, and if antiseptic precautions are taken there will not be that risk of inflammation and suppuration in the cyst which constituted the chief objection in former times to this procedure. The drainage must, however, be carefully attended to, as otherwise annoyance or danger will arise. Laying the sac open and applying caustic to the lining, so as to cause its destruction, is a practice now seldom followed.

Excision has its chief use in dermoid cysts, and in multilocular cysts which threaten asphyxia, when no less serious or difficult plan of treating them is available. Experience does not, however, encourage these operations, and they have proved, in the case of large cysts, very difficult and sometimes very disastrous. The deep relations of these growths are frequently such that extirpation is impossible.

The ligature is not adapted for the removal of cysts of the neck, though in cases of attempted excision, the deeper portions may sometimes be thus dealt with.

Surgical Affections of the Thyroid Gland.

This very vascular gland, lying on either side of the upper part of the trachea, in near proximity to the great bloodvessels, is a ductless, encapsuled body, largely supplied with lymphatics, and consisting of a cellular structure of firm texture, pervaded by a glairy, gummy, yellowish fluid, which coagulates when heated. The two lateral portions of the thyroid, which lie on either side of the windpipe, are connected by a bridge or isthmus which covers the three upper rings of the trachea, where also an intermediate lobe or pyramid may exist.[1]

The thyroid varies considerably in size in different persons, and may atrophy and almost disappear in the old. It is liable to temporary enlargement during menstruation and pregnancy, afterwards resuming its normal size, or nearly so, and no change of structure being caused by such increase. Permanent enlargement occasions that condition which is called "bronchocele," or "goitre," or, in England, "Derbyshire neck." There is great variety in the degree of this abiding enlargement. It may cause only a certain broadening of the neck, which attracts little observation, or it may produce a great pendulous mass covering the whole front of the neck, and in extreme cases extending down in front of the abdomen.[2]

Hypertrophy of the thyroid, or goitre, may be simple and without much structural change. It appears to be more common on the right side than on the left, and may be confined to one side and the isthmus, or at least these parts may be developed out of all proportion to the rest of the gland. Goitres have been variously classified according to their structure. The terms solid and liquid goitres, cystic and parenchymatous, etc., have been proposed as distinguishing the leading forms. The cysts of which these growths may be chiefly composed, vary widely in size, shape, contents, etc. The contents may be a clear and albuminous fluid, or a gummy, gluey, or jelly like material, or may consist of blood, or may be made up even of calcareous matter. The interior of the cyst may also present much diversity as to shape and construction. The cavity may be divided by septa more or less complete. The walls, sometimes thin and pliant, are at other times hard and rigid, with calcareous and osseous deposits. These walls are firmly attached to the gland, but only loosely connected with the surrounding structures. When the walls are thus hard and dense, the disease has been termed "cartilaginous" or "osseous" goitre. A considerable amount of the growth may consist of dilated bloodvessels, and if these burst so as to allow of bleeding into the substance of the tumor (into the cyst, or into the parenchyma), a species of apoplexy is produced. If it be the arteries which are chiefly enlarged and convoluted, the goitre has been designated "aneurismal," while if it be the veins which are mainly involved, it is termed "varicose" goitre. Both sets of vessels, however, but in varying degrees, are commonly affected.[1] Expansile pulsation, vibratory thrill, and "bruit de souffle" have been occasionally observed in aneurismal bronchocele.

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[1] See Boéchat, Recherches sur la Structure du Corps Thyroïde. Paris, 1873; and Burns, op. cit.

[2] See Berger, Archives Générales de Médecine, 1874; also Virchow, Krankhaften Geschwülste.

The worst forms of goitre are met with in the narrow valleys running into the great mountain ranges of Asia, Europe, and America. In many of these localities it is endemic. It is met with in France, Savoy, and Switzerland; in the chalky parts of England and Central Scotland; in the valleys of the Himalayas, and in Thibet and Oude; in the Atlas range of North Africa; in the Cordilleras of South America, and in Chili and Peru; in Mexico and in Virginia, and in other mountainous regions of North America. I have repeatedly seen it in patients from the high-lying districts in the centre of Scotland, where it is little known to exist. A condition similar to that seen in man is occasionally found in dogs, horses, cows, and cats.

Etiology of Goitre.—The hereditary character of goitre has not been clearly established, though it is often asserted. When both parents suffer from the disease, the children are usually similarly affected, and are not unfrequently cretins and idiots. Whether, however, this result is not more correctly to be ascribed to the identity of exciting causes acting on both children and parents, rather than to any inborn influence, is at least a fair contention. The true cause of goitre has probably yet to be found. It has been diligently sought after and abundantly discussed. Coarse food; impure water, from mixture with snow or calcareous matter (sulphate or carbonate of lime); vitiated air; want of sunlight; a constant residence in low-lying and damp, or in elevated, cold, and exposed habitations; a "peculiar state" of the atmosphere; physical conformation of the country; extremes of temperature; intermarriage within a narrow circle; repeated congestions of the neck from violent efforts which force the blood into the vessels of the head and oppose its return—have all been described as its cause; but none of these are constant concomitants, and at best are only entitled to be considered as predisposing causes.

Symptoms.—Goitre is usually chronic in its progress, and may long remain stationary. Perhaps the most remarkable instances of acute bronchocele are those recorded in 1861 by Collin,[2] as having occurred at Briançon the year before.

Women, especially those of a sanguineo-lymphatic constitution, are most subject to it. It seldom becomes developed till after a child has reached ten years of age, though it has been seen in rare cases to appear shortly after birth.

A goitrous tumor rises and falls in deglutition, and is, as a rule, painless, and covered by unchanged skin, whose veins are unusually evident. It may be smooth or lobed, and of various shapes. It may exert severe and even dangerous pressure on the windpipe ("*goître suffocant*"), and may cause alteration or loss of voice, and dysphagia. It has been seen to surround the trachea, and penetrate between it and the œsophagus, so as to compress both passages. The trachea may be thus flattened or pushed to one side. The great vessels and nerves, too, may be constricted by its wedging itself behind the sternum, and this has followed from goitres of even small dimensions when so placed.

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[1] See Heidenreich, Der Kropf. 1845.

[2] Recueil de Mémoires de Méd. de Chir. et de Phar. Militaires. 1861.

Diagnosis.—Goitre is distinguished from glandular tumors by its point of origin, and by its consisting of one or two slowly-growing masses, and not of multiple swellings, at first distinct and finally coalescing, and occurring in different positions from that of the thyroid bodies. Hydroceles of the neck, abscesses, and hydatids, have all a different clinical history, and, for the most part, a different position, and their physical characters and progress are different. An aneurism of the carotid is altogether distinct in position, character, and effects. Tubercular disease is rare in the thyroid, is indolent in its progress, occurs in persons of a special diathesis, and is commonly combined with similar disease elsewhere. Disseminated abscesses and fistulous openings, too, are usual in tubercular affections.

Scirrhus is known by its hardness, mode of growth, fixation, bossy and irregular outline, absence of fluctuation and pulsation, great pain and rapidly-established pressure-effects, and by its influence on the general health.

Treatment.—Internal remedies are of little use when bronchocele has attained a great size. When recent, and of small or moderate dimensions, such remedies may prove serviceable in the measure with which they improve the general health and vigor, and correct those conditions on which the disease may depend. The removal of the patient from the district in which the disease has been contracted to a healthier one, careful attention to the sanitary surroundings of his dwelling, and also to his food and water supply, are measures which at once suggest themselves. If any of those supposed causes which have been already alluded to be in action, they must be removed or counteracted.

Iodine, given internally, has long enjoyed a large measure of confidence in the treatment of bronchocele. Sponge, first used by the Arabians, was administered as an electuary, or in the form of pastilles, tablets, etc. It was also burned and applied externally, as well as given internally. Coindet, of Geneva (whose name is intimately connected with this subject), used the hydriodate [iodide] of potassium, which is, perhaps, still the best preparation of iodine to use in this affection. It should be given freely, and is well combined with quinine and iron. "Lugol's solution" (that is, iodine, 20 grains; iodide of potassium, 30 grains; water, 1 ounce; dose, six to twenty minims) is also a very favorite prescription with many. Iodine, however, is used in a great variety of ways in the treatment of goitre, and in doses of all degrees of concentration. It has been exhibited in natural and artificial mineral waters, in food, in wine and milk, and even in cigars and snuff, but few now-a-days have the same faith in it as formerly, or believe it to possess any "specific" action in bronchocele. When combined with iron and accompanied by other measures tending to improve the general health, it is no doubt very useful.

Every kind of local treatment of goitre has had its advocates. Leeches, purging, counter-irritation, and electricity have all been tried and found of no avail, unless to relieve congestion or the slighter forms of hypertrophy. Iodine is the most commonly employed external application. In the form of tincture, or as an ointment variously combined with camphor, lead, mercury, etc., it has long been used in both the cystic and solid forms of goitre. In the East Indies, the biniodide of mercury (ʒiij to the pound of lard) has a high repute. According to Mouat[1] it is best rubbed in, in the early morning, for about ten minutes, a fresh portion being then applied, and left to be absorbed, while the tumor is exposed to the heat of the sun. When the skin becomes irritated, the application should be desisted from till the part is again free from pain. I have, in Scotland, occasionally seen much good result from this treatment, fire-heat being substituted for the sun's rays. The action of the remedy is apt to be too violent unless watched. The compound iodine ointment of the British Pharmacopœia, the iodide of ammonium ("colorless iodine"), equal parts of camphorated mercurial ointment and iodine, are other forms of the application which are sometimes used.

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[1] Indian Annals of Medical Sciences, 1857.

Cysts may be simply tapped, or may be injected as well as emptied. Mere tapping can only afford, as a rule, temporary relief, and, however carefully managed, has not always proved free from danger.[1] Rarely has it led to a cure, as it did in a case related by Gosselin. Consecutive hemorrhage and profuse suppuration have occasionally followed mere tapping. Iodine is the favorite substance chosen for injection, but alcohol, ergot, and perchloride of iron are also used. The tincture of iodine, mixed with water in the proportion of one to four, or stronger, or combined with camphor or alcohol, has been frequently employed. Dr. Morell Mackenzie[2] prefers a drachm of the tincture of the perchloride of iron in half an ounce of water, injected after drawing off the fluid by a dependent, central puncture, with a trocar and canula. The canula is left in place and plugged after the injection is made, so that the iron solution may be re-introduced at intervals of a few days, till suppuration is set up, after which the tube is withdrawn and poultices are applied, and the affection treated as a chronic abscess. Iodine, iodide of potassium, camphorated spirit of wine and rose-water, are recommended by Bouchacourt.[3] Maunoir used wine, but it is wholly inefficient.

In old, hard goitres, interstitial injections are powerless. Nothing short of removal is of much service in such cases. It is in the cystic and glandular forms that injections of iodine are of most value; and though it is not unusual for the immediate effects to be violent, and even alarming, yet in a few days the beneficial results will show themselves. The surgeon must proceed with caution, and be guided as to the strength of the injection and its repetition, by the effects of the last operation. In vascular goitres, solutions of the perchloride of iron are to be preferred.

Incision followed by plugging has also been employed in the treatment of cysts of the thyroid. Portions of the cyst may at the same time be removed. Violent and irrepressible bleeding has, however, thus been occasioned, and has ended most disastrously. Billroth's experience of this method has been very unfavorable. Caustics and the actual cautery have also been used to open the cavity of the cyst, so as to diminish the risk of bleeding; and pieces of caustic have been suspended within the cyst, in the delusive hope of diminishing the dangers of using the knife.

The wire or thread seton is also another method of treatment which has been practised; but here, too, violent bleeding and inflammation have arisen, and have ended fatally.

Pressure has been well spoken of by an American surgeon, Dr. Dwight.[4] He applied it by means of adhesive plaster.

In the vascular form of goitre it has been proposed to tie the main vessels leading to the tumor. This operation is difficult and dangerous, and has been attended with little benefit, as the collateral circulation is very easily established.

In the solid forms of goitre, various methods of treatment have been attempted. Electricity, crushing, breaking up with a trocar, interstitial injection, the seton, etc., have all been tried with the object of bringing about absorption. The biniodide ointment, used as already described, has also been employed for this form of the affection. When other means fail, excision may be thought of in favorable cases, but is a proceeding so formidable that few surgeons have had the courage to attempt it. In the words of Dr. Greene, "accurate anatomical knowledge and a perfect self-control under the most trying ordeals through which a surgeon can pass, are indispensable to its performance." Yet it has been done, and that successfully, in very formidable cases. The ligature was used by Moreau, Desault, Mayor, and others, but with very indifferent success. The knife has been preferred by some, and while in not a few cases the bleeding has been very great—so profuse as to cause the arrest of the operation—it has been successfully commanded in others without much difficulty. Some patients, however, have died of hemorrhage, either at the time of the operation or shortly afterwards; and that excision is not an operation to be undertaken by surgeons without experience in perilous undertakings, or in other than exceptional circumstances, must be admitted. It appears to have been first performed by Desault, and since then has frequently been executed both in Europe and America, and the successful cases have been about two-thirds of those operated on.[1] Greene, in 1871, described the method which, as subsequently improved by Dr. Heron Watson, of Edinburgh,[2] Prof. Billroth, and others, is that now generally followed. An incision is made in the middle line down to the capsule of the gland. This incision must be free, and may extend from the chin to the sternum. In this there is little bleeding. The tumor is then enucleated without opening the capsule. This is done rapidly with the finger. The lateral and anterior connections having been broken up, and the sterno-mastoid muscles held aside, the superior and inferior thyroid arteries are secured by double ligatures, where they enter the tumor at its upper and lower angles. The various veins are also tied as they are encountered round the circumference of the growth, till the whole vascular circle has been made secure. The vessels are then divided between the ligatures by which they have been tied, and the mass removed. Greene did not stop to secure the lesser vessels, but sought rapidly for the pedicle and tied it. Where the pedicle is large, or when some part of the growth cannot be isolated, the *écraseur* may be employed. The galvano-cautery has also been suggested, but the careful and systematic deligation of each vessel is the most reliable plan to follow. Primary and secondary hemorrhage are beyond doubt the most serious dangers, and these have occasioned the most appalling catastrophes when the capsule has been opened and when the vessels have not been systematically and completely secured. Shock, septicæmia, and diffuse cellulitis have also proved fatal after this operation.

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[1] See Gaz. des Hôpitaux, 1857.

[2] Lancet, 1872; and Transactions of Clinical Society of London, 1874.

[3] Bulletin de Thérapeutique, 1849.

[4] Transactions of the American Medical Association, vol. iv., 1851.

Ligature of the thyroid arteries, and also of the carotid, has been employed in the treatment of goitre, when highly vascular, without the tumor being otherwise interfered with; but, as has been already said, these operations are not only difficult, but have not been attended with such success as to encourage their repetition.

When suffocation threatens a patient suffering from goitre, we have to consider whether it is due to temporary congestion which can be relieved by local depletion and the application of ice, etc., or whether, as is more usual, it arises from the permanent pressure of the growth. If there be a distended cyst, then tapping may give rapid relief; but if the tumor be solid, no aid can be thus got. Tracheotomy may be impossible from the position and size of the growth, from the displacement of the windpipe (which is so apt to occur), or from the presence of large bloodvessels, and even if it can be managed it may prove abortive from the low point at which the compression acts, and from the narrowing which the windpipe has undergone, or, perhaps, from the tumor having passed behind the trachea. The longitudinal division of the tissues lying over the windpipe in the middle line, or the subcutaneous severance of the aponeurosis and muscles "at the seat of greatest constriction," have been suggested, but these measures are open to very obvious objections when we consider the disposition, situation, and structure of the growth which is the cause of the pressure.

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[1] Kocher, Correspondenzblatt; Welch, Trans. Am. Med. Assoc., 1878.

[2] Edin. Med. Journal, Sept. 1873.

EXOPHTHALMIC GOITRE.—In that form of goitre described by Basedow and Graves, and commonly known as exophthalmic goitre, or the goitre of spanæmia, the protrusion of the eyeball is a marked and characteristic feature. The patients most liable to it are females whose health has been depressed by loss of blood, feeble digestion, leucorrhœa, prolonged mental anxiety, or overwork. The heart is usually irritable, and it may have its cavities dilated and its sounds altered. The pulse is weak and rapid. There is excessive action of the great arteries in the neck, and the patient complains of throbbing in the head, tinnitus aurium, palpitation, and great nervous depression. The cause of the protrusion of the eyeballs has been much discussed. The distension of the bloodvessels within the orbit, and possibly hyperplasia of the cellular tissue and fat there, have been credited with producing this effect, while changes in the cervical ganglia of the sympathetic have also been said to account for it. No single condition, however, has been found so constantly as to properly be considered the true and invariable cause, though there seems good reason to suppose that the chief phenomena which mark the affection are referable to morbid changes in the middle and lower ganglia of the sympathetic nerve. It is, however, as bearing on the thyroid body that this curious disease comes to be spoken of here. The thyroid becomes enlarged, though rarely to any great degree. It becomes very vascular, and is often covered by large, prominent veins. It may be markedly moved by the pulsations of the neighboring great arteries, and may undergo increase with any excitement in the circulation. One lobe may be specially enlarged. It is usually soft at first, but when of long standing may become very hard and resistant. It seldom suppurates, but may inflame or break down; and if the surface gives way, a very malignant-looking sore may be the consequence. The *etiology* and *pathology* of this disease are as yet very unsatisfactorily determined, notwithstanding all the labor which has been expended on it, and the *treatment* is mainly based on an endeavor to improve the general health and recruit the blood, and so diminish the nervous exhaustion which is so marked a condition. Attention to the digestion, the diet, and the hygienic surroundings of the patient, the avoidance of mental strain, the arrest of all wasting discharges, and the administration of iron, digitalis, and strychnia, either separately or combined, or quinine and belladonna, have been found most useful. Iodine has also been employed, but it is in iron, digitalis, and strychnia that confidence is most placed. Ice has, in the early stages, been much used for this enlargement of the thyroid, and iodine, with compression, in the later conditions of the gland. The state of the thyroid will, however, depend mainly on the condition of the general health, so that it is to its amendment that attention should be chiefly directed.[1]

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[1] See Graves, Clinical Medicine; Dublin Hospital Gaz., June, 1860; Stokes, Diseases of the Heart; Virchow, Die cellular Pathologie; Laycock, Brit. and For. Med.-Chir. Review, 1864, and Medical Times and Gaz. vol. ii. 1864; Trousseau, Clinique Médicale; Greene, Medical Record, 1871; Buffalo Med. Journal, 1851; Begbie, Practitioner; Charcot, Gaz. Méd. de Paris, 1856; and Trousseau, Ibid., 1862.

TUMORS OF THE THYROID.—*Adenoid growths* occasionally occur in the thyroid, and lie imbedded in its substance. They form outgrowths, and are more or less detached, and so capable of being enucleated.

Carcinoma occasionally attacks the thyroid, and that usually subsequent to its appearance in the neighborhood or elsewhere. It is very rarely seen as a primary affection, though cases of reputed cancer have been not very uncommonly reported. All forms of carcinoma have been met with in this organ, but the soft or brain-like cancer is perhaps the most common. The rapidity of growth, the great pain, the marked pressure-effects, the invasion of the skin and the parts around (especially the windpipe and pharynx), and the propagation of the disease to glands, lungs, etc., together with the disastrous influence it has on the general health, proclaim the nature of the affection. There may be sanguineous cysts formed in the carcinomatous mass; and, if the skin gives way, a malignant ulcer may be established. The great bloodvessels may be opened, and the inevitable death hastened by bleeding.

The clinical history, physical features, and progress of malignant growths of the thyroid, differentiate them from all those of a simple character, which are for the most part smooth and of rounded outline, of soft consistence (fluctuant, perhaps), of slow growth, painless for the most part, causing pressure-effects only when they have attained a great size, and not involving the overlying or surrounding parts, or the constitution.

In dealing with tumors of the thyroid, it is, of course, essential to obtain a distinct knowledge of their nature, as otherwise neither their progress nor treatment can be determined. Not only the clinical history of the growth—its origin and progress—but its exact anatomical position and its connections, together with the state of the surrounding parts and the effects it occasions, must be carefully studied and considered. Whether it occupies the whole gland or part only; in what portion of the gland it has begun, and whether it has penetrated deeply or not into the tissues; what has been its rate of progress, and whether its growth has been regular or the reverse; whether its increase has been expedited by any temporary cause, such as pregnancy, menstruation, etc.; what is its consistence at all parts of its surface; its mobility on the underlying and in the surrounding parts, and the state of the skin and bloodvessels over it; its weight, if it can be poised on the fingers; its movement with deglutition; the presence of pulsation or fremitus; the effects of forced expiratory efforts on it; its pressure-effects on windpipe, œsophagus, bloodvessels, and nerves; the presence of pain locally or at a distance, as caused by it, and the state of the general health—these, with an inquiry into any inherited tendency, or any connection by residence with specially unhealthy localities, will supply materials for a sound opinion.

The surgeon will probably determine first whether the tumor is simple or malignant, and, if simple, then what species of innocent growth it is. Cysts and solid tumors are usually easily distinguished; yet there are many cysts which, from their tenseness, the thickness or hardness of their walls, and the nature of their contents, are easily mistaken for solid growths. The shape, weight, resistance, and pressure-effects are generally characteristic, in solid tumors, and the speed with which they grow will vary according as they consist of fibrous, cartilaginous, or bony elements.

By the aspirator the contents of cysts can be determined, but it is undesirable to have recourse to puncture if not really necessary. Much irritation may thus be occasioned, and violent bleeding has sometimes given much trouble. Cysts of the thyroid are to be distinguished from congenital, unilateral, simple cysts of the neck, by their position and history, and the fact that they are firmer and not transparent, and are accompanied by an alteration in the whole thyroid body. The congenital simple cysts and the compound cysts of the neck do not, as a rule, occasion the pressure-effects which result from those cysts which form in connection with the thyroid, and their movement with the trachea is not so marked. Cysts of the thyroid, too, do not show below the tongue, as congenital cysts are apt to do.

Remarkable errors have been made between highly vascular goitres and aneurismal tumors. This has been due to the presence of expansile pulsation, *souffle*, etc., in both. A careful inquiry into the mode and exact place of origin, the extent, shape, and consistence of the tumor, together with an observation of the effects of pressure applied in turn to each carotid at the root of the neck; the movements of the tumor with deglutition; the absence of any decided reducibility, or of effects detectable in the arteries beyond the growth; also, the state of the superficial veins, and, possibly, even the influence of internal treatment by iodine and tonics, will clear up the diagnosis.

The rapid enlargement which the thyroid occasionally undergoes as the result of inflammation and congestion, is easily recognized. It is seen at times as the result of injury to a pre-existing, though perhaps little observed, goitre. The violent pain increased on pressure and movement; the local signs of inflammation (heat, redness, and swelling), and the serious fever which it occasions, together with the quickly-established pressure-effects, and the influence of antiphlogistic treatment, will conjoin to distinguish it.

The chronic glandular hypertrophy and lymphoma of the neck, have had their characters fully described. In the former, the enlargements are almost always multiple and in chains, in the well-known position of the lymphatic glands. Firm or hard, painless as a rule, slow of growth, with unaltered skin, and, possibly, with concomitant evidence of a strumous diathesis, the nature of these tumors will usually be apparent. They have not the same position as that occupied by thyroid growths, do not occasion the same local effects, and do not follow the movements of the windpipe in deglutition.

Surgical Affections of the Parotid Gland.

The parotid is the largest of the salivary glands, and lies on the ramus of the lower jaw, passing also deeply behind it and between it and the mastoid process, being thus in close relation with most important structures. The external carotid artery with its great terminal branches, together with the veins which accompany them, the facial nerve and its important divisions, with branches from the cervical plexus, are imbedded in it, while the internal carotid and internal jugular, the spinal accessory, glosso-pharyngeal and vagus nerves lie close to its deep surface. It is inclosed, except its pharyngeal surface, in a strong fibrous sheath, and its duct, which is a resistant, fibrous tube lined by mucous membrane, opens within the cheek opposite the second molar tooth of the upper jaw. Cellular tissue and muscle lie over or superficial to the parotid, so that it is firmly bound down and covered on its outer aspect, but the deficiency of its capsule on the deep or pharyngeal surface has an important bearing on the direction taken by pus when formed deeply within the gland, and by cancerous growths in their extension. The parotid varies considerably in size, within the limits of health, and it is occasionally the seat of inflammation and of various growths. Many absorbent glands exist over, within, and below the parotid, and as they derive lymphatic vessels from the velum and gums, they are liable to many sources of irritation.

Some authors have described a curious *sweating or distillation of salivary fluid*, from minute points in the skin over the parotid, during eating, and in one case[1] in which this was observed, it was found after death that the parotid ducts were obliterated; yet Brown-Séquard[1] and others have tried to disprove the nature of the transudation, and to show that it is mere perspiration escaping in excessive quantity.

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[1] Baillanger, Bull. de l'Acad. de Médecine. Paris, 1847.

Parotitis, or mumps, is a common affection which attacks one gland, or occasionally both, and that simultaneously or in succession, in young males chiefly, and which at times assumes an epidemic character. It is most common before puberty, but has been observed not only in adults but even beyond middle life. In schools and public institutions it has now and then affected large numbers, especially in spring and autumn, when cold and damp have been thought to originate it. Its exact pathology has been much discussed.[2] It has been ascribed to rheumatism, has been classed with the eruptive fevers, and, as it is commonly preceded or accompanied by inflammation of the fauces, has been thought by many, in all cases, to proceed by continuity of tissue along the duct. It reaches its acme in two or three days, and in eight or ten days it disappears. Parotitis causes considerable local swelling, which, however, may so spread as to involve the whole side of the neck, especially if the other salivary glands become affected, as they sometimes do. There is no heat or redness, but the pain is considerable, especially during mastication and deglutition. This pain is little if at all aggravated by pressure, as long as no suppuration follows. The attack may be ushered in by chills, sickness, headache, and elevated temperature, and by so much constitutional disturbance as to deceive the practitioner regarding the nature of the ailment, and lead him to expect some serious eruptive fever; but this only occurs in exceptional cases, as in general there is little or no fever present from first to last. The transference of the inflammation from the parotid to the testicle or mamma, which occasionally (in 2 or 3 per cent. of the cases) occurs about the fifth or sixth day of the attack, is a curious and unaccountable complication of this ailment. It is not as often seen to involve the mammary gland as the testicle, but it does so occasionally, and may implicate the uterus and ovaries as well. The parotitis more rarely follows the orchitis.[3] The testicle on the same side as the affected parotid is that usually involved, but this is not always the case. The transference is most often observed in patients who are of somewhat advanced age. Of late years attempts have been made to throw doubt on this "metastasis," as it has been called, to the testicle, and to allege that when orchitis has appeared there has always been a latent gonorrhœa. I have had most conclusive evidence of the untenableness of this view, but am inclined to think that masturbation during the attack of mumps, had, at least in one case, some influence in attracting the inflammation to the testes. Various other complications in the ear, eye, tonsils, and brain, have been recorded as following parotitis.[4]

Mumps as a rule subsides spontaneously, and leaves no harm behind, unless a little thickening which disappears in a short time if not interfered with. A blister may occasionally, however, be thought desirable, to hasten the dispersion of the condensation.

As to the *treatment* of the ordinary simple parotitis, little need be said, as rest of the part (using soft food), fomentations, simple or medicated with chamomile flowers, and the use of a saline, are all the remedies which it usually demands. Liniments containing belladonna, camphor, or iodine, are frequently employed after the acute stage. The soap and opium liniment, alone or combined with chloroform liniment, twice as much of the former as of the latter, does very well to remove the stiffness which remains. Leeches and cold are not used, and blisters are seldom required. If the inflammation in a lymphatic gland, however, were very acute, of course local depletion might be useful. Many prefer to cover a simple swelled parotid with cotton wadding, and to abstain from all active local treatment. As a rule, I have myself found this quite sufficient.

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[1] Journal de Physiol., tome ii.

[2] Trousseau, Clinique Médicale; Pitha und Bilroth, Handbuch, Bd. iii. S. 373; Gosselin, Clinique; and Vidal, "Des Oreillons."

[3] Billoir, Gaz. des Hôpitaux, 1850.

[4] Trousseau, Archives Générales de Médecine, 1854.

The orchitis which occasionally arises during the course of parotitis is easily managed. Rest, fomentations, and elevation of the part, will soon subdue it. Leeches, if used, assist the induction of that atrophy which occasionally follows, and therefore should not be applied. Leeches too are very troublesome when applied to the scrotum or cord. Blisters and caustics are even more objectionable. It is useless to try and attract the inflammation again to the parotid, by blisters applied to it, if the testis be already involved. Time and rest will do more than active treatment to secure an effectual and safe recovery. The administration of mercury and iodide of potassium, as recommended by some, is unnecessary.

Suppurative Parotitis (*Parotid Bubo*).—In weakly subjects, and in depressed conditions, as after child-birth, erysipelas, typhoid fever, diphtheria, and smallpox, or in the course of septicæmia, from a too prolonged course of mercury, or from closure of Steno's duct, suppuration may occur in the parotid after an attack of acute "phlegmonous" inflammation within the gland, and it is not so very unusual for it to implicate the cellular tissue which lies over it. The pus, when formed within the strong capsule of the gland, has great difficulty in coming to the surface, and may work havoc in various directions. It may pass downwards even into the chest, upwards along the sheath of the vessel into the skull, backwards behind the pharynx, or into the ear and the articulation of the lower jaw. It is therefore necessary to give early vent to an abscess situated in the parotid. If the pus lies external to the gland, the incision made should correspond in direction to the course of the facial nerve, but if the gland has to be cut into, the knife should be carried parallel to the external carotid, one or more of whose branches may possibly be wounded notwithstanding every care. A director and dressing forceps should be employed to reach the pus if it be deep, and antiseptic dressings should be used, as violent and dangerous bleeding, thrombosis, and blood-poisoning have followed deep wounds in the parotid. Sloughing, and even what has been designated as mortification, have been seen after violent inflammation, and this will be the more readily produced if, when an abscess forms, early and effectual drainage be not secured. It is not in the parotid gland that inflammation leading to troublesome suppuration is so commonly seen, as in the lymphatic glands which lie in and especially below the parotid. Such inflammation causes the usual local signs of its presence. The redness is occasionally erysipelatous, while there is heat, with acute pain increased on pressure and movement. There is also marked constitutional disturbance. The swelling is often great, and the cavity of the mouth inflamed, while the pressure caused by the swelling may not only occasion great pain and tension, but may interfere with the return of blood from the brain, and so bring on delirium and other troublesome symptoms. The pus has a horrid fetor from being mixed with air, and it may collect in one large or several small abscesses. Recovery is often protracted, and relapses are not unfrequent. Disagreeable marking, parotid fistula, and facial paralysis may eventuate from extensive suppuration in this region. If the inflammation is acute, it will require to be promptly and actively treated by leeches and repeated blisters, and if pus forms, by an early incision.

PAROTID FISTULA.—Steno's duct may become occluded either by adhesions following acute inflammation—as in violent salivation, or during the healing of wounds—or by calculi (phosphatic) which sometimes form within it. A more or less complete arrest of the flow of saliva will result, and an oval fluctuating tumor will form in the line of the duct. The size of this cyst-like tumor will probably be seen to increase during mastication, and, if it burst externally, a salivary fistula may be established. Fistulæ may either be connected with the parotid itself, and be placed over some part of its surface, or in its neighborhood though beyond its limits; or they may open into Steno's duct.[1] The orifice of the fistula may be so small as to be difficult of detection unless it be elevated, as it sometimes is, on a small papilla, or sunk into a little pit, or unless it be red and irritated by the discharge, so as to mark its presence. The flow of the saliva may be readily increased by the patient chewing some pungent substance, or placing a bit of lemon on the tongue, and then the distillation of the saliva by the orifice may be seen, and the nature of the secretion exactly determined by chemical tests. If the external orifice is large enough to allow of a colored injection (milk, or a solution of iodine) being thrown along the duct into the mouth, or in the reverse way, or of a probe being passed through it, then all doubt will be removed. Small fistulæ connected with the gland are usually cured easily, if seen early. In truth, they not unfrequently close spontaneously, if any obstruction which was present is removed, but fistulous orifices connected with Steno's duct, especially if long open, are very difficult to rectify. The application of various caustics, especially a pointed piece of lunar caustic, is a favorite and simple remedy which in slight cases may succeed, especially if combined with well-adjusted pressure and rest to the part. The galvanic cautery at a low heat, or a hot needle, is however more reliable. All sorts of injections have also been used—wine, alcohol, caustic solutions, iron, iodine, etc.—but little advantage follows their employment. In fistula of the duct an infinite number of remedies have been suggested. Some aim at re-establishing the duct, if partially or wholly closed; some aim at forming a new orifice for the duct within the mouth; some try to arrest the secretion of the saliva by destroying the parotid gland; and others employ various methods for merely closing the opening on the cheek by plastic or other operations.

If the duct is obstructed between the fistulous opening and the mouth, a fine leaden probe, or a firm piece of catgut, may possibly be passed from the mouth along the duct and beyond the fistula, so as to act as a conductor for the saliva, and thus allow the abnormal aperture to close or be dealt with by the surgeon. Setons of wire, silk, etc., have been used in the same way.

A new orifice within the cheek has been secured in various ways. A seton of wire, catgut, cotton, lead, or other material; a trocar and canula (the latter being left in place); the bistoury, followed by a tent, have all been used for this purpose. Deguise's plan has secured considerable favor. He passed a small trocar from the fistulous orifice inwards and backwards, and passed the end of a leaden wire. The trocar was then passed a second time from the original point of introduction, but this time it was carried in the direction of the duct, and the other end of the wire was passed into the mouth. The two free ends of the leaden wire, which now projected into the mouth, were then twisted together within the cheek, thus constricting some of its substance. The external orifice was next closed by the ordinary twisted suture, and its edges became adherent in a few days as the saliva escaped into the mouth along the wires, which were finally removed as the apertures along which they had passed became permanently established as internal openings. Threads of gold, silver, silk, and catgut, have been substituted for the lead, and additional means have been used to constrict and divide the piece of soft tissue inclosed in the loop, without improving Deguise's method.

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[1] Duparcque, Revue Médicale, 1842; and Mém. de la Soc. de Chir., tome ii.; Jarjavay, Ibid., tome iii.

Langenbeck and Van Buren dissected out the extremity of the duct where it opened on the cheek, with a margin of the surrounding tissue, and carried the whole through the cheek into the mouth, fixing it there for some weeks by fine wire sutures, while the outer wound was closed. Professor Horner attained the same end by placing a broad wooden spatula in the mouth, to protect the tongue, and then removing entirely the fistulous orifice with a large sharp punch, so as to drive a hole right through the cheek. The outer wound was then united by the twisted suture.

Maisonneuve tried to cut off the flow of saliva from the parotid, by applying pressure between it and the fistulous opening, and it has been asserted that pressure applied to the parotid itself has brought about its atrophy, and thus arrested the stream of salivary fluid which escaped. These latter remedies, however, need hardly be discussed. Finally, autoplastic operations may be resorted to if an internal orifice have been secured, and if the external opening cannot be otherwise closed.

If a *calculus* is impacted in the duct, its presence can easily be recognized by the swelling and discomfort which it occasions, and by an examination made with one finger within the mouth, and another outside the cheek. These calculi are of an elongated shape, and lie in the axis of the duct. They should be at once removed by a free incision on the buccal surface, while pressure is kept up by the finger outside. They may, if left, occasion the formation of a fistula, by setting up ulceration.

Tumors of the Parotid.—The parotid is occasionally the seat of various tumors of a simple or malignant kind. They may consist of one element, but they are more usually mixed. The simple growths are either mere hypertrophy, which is very rare indeed, or consist of fibrous, cartilaginous, adenoid, fatty, and myxomatous elements. Of malignant tumors, carcinoma is not very rare, while sarcoma is occasionally seen, and the recurrent fibrous [spindle-celled sarcoma] is also met with. Cysts have their seat at times in this region, and these different neoplasms may be variously combined. The lymphatic glands lying over and in the parotid, may become the seat of enlargement, or may be altered in structure; and in this way the surgeon has at times no easy task to distinguish with accuracy the nature of the tumor which he is called upon to treat.

It is by a consideration of the clinical history and physical characters of the tumor, and of its effects on neighboring structures, as well as by observing the age and condition of health of the patient, that a surgeon is chiefly guided in his opinion. The slow, painless growth in an outward direction; the absence of close adhesion to the parts below, above, and around, so that the fingers can, as it were, be inserted below the tumor, and separate it from its surroundings; the healthy condition of the distended skin; the non-existence of facial paralysis and lymphatic gland-irritation as well as of other pressure-effects, and the non-involvement of the general health, would point to the tumor being innocent. The cancers again contrast in all respects with such growths, but in varying degrees according to their special forms. The hard, ill-defined tumors which appear under the ear in persons at or after middle life, early fixed (especially laterally), with pain flashing up to the temple and down the side of the neck, markedly compressing surrounding structures and so interfering with their function, growing rapidly, involving the skin and making it coarse and dark-colored before it gives way, and establishing in time the broad-spreading, deep, characteristic, bleeding ulcer, with hardened chain of glands and dilated veins, with facial paralysis and early embarrassment of deglutition and mastication, very plainly point to the hard and condensed form of carcinoma. Between these two extremes there will be found many diversities and combinations. Carcinomata of the soft form, myxomata, cysts, and cartilaginous tumors, occur mostly in young persons; fibrous and sarcomatous growths before middle life; and hard cancers and epitheliomata in old age. Soft cancers, lymphomata, and sarcomata grow most quickly, and fatty, fibrous, and cartilaginous tumors most slowly.

The shape, outline, and consistence of the tumor, the presence or absence of lobulation, its rapidity and regularity of increase, its size, the state of the overlying skin, the interference of the tumor with function, together with the age and health of the patient, and possibly the family history, will chiefly aid the surgeon in distinguishing the species of growth with which he has to deal.

Simple hypertrophy of the parotid is very rare. The case related by Bérard,[1] and verified after the death of the young patient, and one or two others whose exact nature was not determined, make up the sum of such cases.[2]

The "*glandular parotid tumor*" is perhaps that with which the surgeon is best acquainted. Its pathology has been much debated. At one time it was thought to spring from a lymphatic gland lying in contact with the parotid, at another to be always due to a growth of the parotid gland itself, or of its fibrous envelope.[3] The common parotid tumor is fibrous or glandular for the most part, but has mixed with it cartilaginous masses and often cysts. It compresses the parotid more or less, and may occasion its atrophy and almost total absorption, so that when it is removed a deceptive appearance is produced of the parotid having been excised. These tumors often attain a great size, and are yet movable and but loosely connected. Their surface is irregular, tuberous, lobed, or round, firm and hard at most points, but elastic at others. The skin, though marked by enlarged veins, is not involved or adherent. They lie below, in front of, and behind the ear, and grow slowly and perhaps capriciously, or remain stationary for years. They have no effect on the general health, and cause little pressure as a rule, though facial paralysis, impediment to the venous return from the head, and embarrassment of swallowing and chewing, have in rare cases been observed.

Parotid tumors rarely consist of pure *cartilage*, but the great bulk of them may be formed of that structure, and when soft and quick-growing, as they are in exceptional cases, they may recur after excision. They may be wholly buried in the gland, or be merely pressed into it and covered by the fascia, and the facial nerve may pass through them, be spread over them, or be firmly adherent to their under surface. They usually appear about middle life, and are generally innocent.

The only effectual remedy for these growths is removal, and if they are growing, the sooner this is effected the better, as with increased size comes augmented difficulty. The method of excising them will be hereafter described.

Lipomata are occasionally met with, over, within, and below the parotid, and are recognized by their well-known characters. *Nævi* also occur over the gland, and *cysts* (serous, sanguineous, sebaceous, and compound) form here as elsewhere, but do not demand special description.[4]

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[1] Thèse de Concours, 1841.

[2] Vidal, Traité de Pathologie Externe, tome iii. p. 669–70.

[3] Bérard, Thèse; Bauchet, Mém. de la Soc. de Chir., Juin, 1856; Dolbeau, Mémoire sur les enchondrômes de la parotide, Gaz. Hebdom., 1858.

[4] See Paget, Lectures on Surgical Pathology, 3d edit. 1870.

Carcinoma is not as common an affection of the parotid as was at one time supposed, when no distinction was drawn between it and sarcoma, enchondroma, fibro-plastic and other tumors. All forms of carcinoma have been met with here. The clinical characters of such growths have already been referred to. *Sarcoma* is more common than carcinoma, and cannot in many cases be distinguished from it by its history, or physical and vital effects; but as a rule it does not exert as much pressure, does not involve and destroy the skin in the same way, and does not poison the blood. But sarcoma may show marked local malignancy and return after excision, though as to this we cannot express an opinion till the histological elements of the tumor have been examined. The excision of malignant growths of the parotid is beyond our art, and should not be attempted. They insinuate themselves in and around the important structures in their neighborhood, and backwards toward the pharynx, in a way hardly to be recognized before the parts are opened up. Even after death, it has been found impossible to effect a separation of their prolongations without great destruction of surrounding parts. It has been found impracticable to discover even whether the internal carotid artery, and hypoglossal and other nerves, were not involved, and portions of the growth have been found after death to penetrate the internal jugular vein, without any sign of such a complication having been visible during life. Notwithstanding these considerations, it must yet be allowed that cases are recorded in which the excision of a cancerous parotid is said to have been successfully performed. This point, however, will be again alluded to.

Pure *myxomas* are very rare in the parotid. No distinction, which is of much clinical value, can be drawn between them and sarcomatous growths. They are usually softer and more diffuse, that is, less circumscribed, and more apparently fluctuating.

The *lymphatic glands* lying in contact with the parotid may enlarge and suppurate, or may assume the characters of lymphadenoma and lympho-sarcoma. In the latter case it is only by the clinical history and progress of the tumor, and by an examination of its histological elements, that its true nature can be recognized. Tumors lying over the parotid will, till they attain a considerable size and anchor themselves more firmly, be much more movable than those found in the gland itself—that is, below the strong sheath which incloses the gland—and it is chiefly by observing this mobility, and their greater diffuseness and less limitation to the area of the parotid, that the true seat of the growth is determined.

As to the excision of tumors lying over, or in, the parotid gland—fibrous, cartilaginous, glandular, etc.—it may be said that in many cases the operation is easy enough, though from the size and appearance of the tumor beforehand it may appear very formidable. If, however, there are deep and irregular prolongations of the growth, as when it grows within the capsule of the parotid, and if these have formed close connections with the bloodvessels and nerves behind and below the angle of the jaw, then no operation can be more difficult or dangerous. Mere size is no contra-indication to an operation. Tumors in this region have been removed successfully, which have masked the whole side of the neck. In many cases the bulk is due to the increase of the tumor being solely in an outward direction. The mobility and circumscription of the growth; the possibility of inserting the fingers below it, and, as it were, raising it up; the freedom from pressure-effects on bloodvessels and nerves; the healthy state of the skin and the lymphatic glands; the rate and direction of the tumor's increase, together with the age and state of health of the patient, and the possibility of removing the whole mass, will chiefly influence the judgment in determining for or against an operation.

In excising simple growths, the overlying parts should be freely divided down to the tumor itself. If it is encapsuled, the growth should then be enucleated with as little dissection as possible—the finger and handle of the knife being chiefly employed. An incision passing down the posterior surface of the tumor, and another leaving the first at either its centre or lower end, and running forwards, generally best meet the requirements of these cases. If deep dissection be required, the parts to be divided should be scraped through only after careful inspection, and the securing of each doubtful portion by two ligatures before division. Drainage must be very carefully provided for, and no skin should be removed unless it be diseased. If important bloodvessels running through the tumor are divided, they can be secured without much difficulty, and it is well to dissect from below upwards (as all operators have stated), and from behind forwards, so as to tie at once the main bloodvessels which are necessarily cut, and not have to ligature them again and again in the course of the operation. It has been shown that if the main trunk of the facial nerve be divided, and its cut ends placed together, the function of the nerve will be restored. It would be well in such a case to unite the extremities of the nerve by suture. The common carotid is not now tied as formerly, preparatory to the excision of tumors of the parotid, and the use of the *écraseur* and galvano-cautery is seldom thought of, though the latter instrument might, in complicated cases, be found of much use.

It is right to add that the possibility of excising the parotid has been the subject of much controversy. That in its unchanged condition it is impossible to define accurately its limits so as to take it all away without injury to surrounding structures, has been asserted since Allan Burns and others studied the question ; but that it can be removed when so altered by disease as to become more defined, prominent, and prehensible, must be admitted.[1] Nélaton, Malgaigne, and many others have taken a prominent part in this discussion, but the terms of the question debated have not always been identical. To excise a sound, unchanged parotid, and one affected with cancer, are very different things ; and these again differ widely from dealing with a parotid, the seat of affections which have not the tendency to burst the capsule of the gland, and spread far and wide, working themselves into the surrounding parts as malignant tumors do. It is from not observing this difference in the problem, that much of the diversity of opinion which is so copiously expressed in the writings of several authors has arisen.[2] It is not necessary here to enter on this question. In America, excision of the diseased parotid has been, perhaps, more frequently reported than elsewhere. Warren of Boston, in 1798, led the way, and McClellan, of Philadelphia, several times repeated the operation. Many cases (over one hundred) are on record in which it is said to have been performed, but there is strong reason to suppose that in a certain proportion of these it was not the gland itself, but a tumor deeply imbedded in it, which was removed. Malgaigne, in his report to the Academy, even went the length of asserting that the diseased parotid could be excised without injuring either the external carotid or the facial nerve. Paralysis of the portio dura may, however, be always looked for when the parotid is seriously dealt with, and the bleeding cannot fail to be very severe, so that it is in any case an operation which demands experience and mature knowledge in the surgeon who undertakes it. The incision employed is usually a straight one, but it may assume other directions to suit the case in hand. A ⊣-shaped or ⌋-shaped wound is often preferred. It should freely expose the mass, and should make ample provision for drainage. The tumor is best detached from below and behind, upwards and forwards, though Malgaigne and others dissected it from above. It is in dealing with the back of the growth that difficulties chiefly arise. The surgeon must keep close to the tumor, and examine well every fibre before dividing it, scratching and tearing, rather than cutting. The digastric muscle may have to be severed, and each vessel opened must be at once secured. It has been found comparatively easy to compress and tie the external carotid as it enters the tumor. It should be tied with a double ligature. Malgaigne shows how opening the mouth freely, enlarges the space behind the angle of the jaw, and so facilitates the separation of the deeper portions of the growth. If too much traction be made, the internal carotid and jugular may be so displaced as to come within the field of operation. This should be carefully avoided. The large terminal branches of the external carotid will be cut as the upper end of the tumor is detached. The facial nerve cannot escape, unless the growth be so friable that it can be teased out.

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[1] See Bérard, Des opérations que reclament les tumeurs développées dans la région parotidienne. 1841.

[2] Bulletin de l'Académie de Médecine, Octobre, 1858.

Ligature of the carotid, in order to induce atrophy of the parotid gland, has not been found to succeed, from the great freedom of anastomosis; and removal of the gland by ligature and caustic has signally failed.

Affections of the Submaxillary Gland.

The submaxillary gland resembles the parotid in respect to the growths to which it is liable. It is inclosed in a very perfect fibrous capsule, derived from the cervical fascia. Its duct ("Wharton's") may be obstructed by calculi of the same chemical composition as those found in Steno's duct; and in consequence of inflammatory adhesions, the escape of saliva may be so impeded, that a soft, fluctuating swelling forms in the floor of the mouth, due to its accumulation. This is not ranula, but was long confused with it. If from any cause the secretion from the submaxillary duct does not get free vent, engorgement, and (if prolonged) permanent enlargement, of the gland may be caused. The presence of a concretion is best made out by placing one finger in the floor of the mouth and one below the jaw, so as to compress the duct between the fingers, and then rolling one finger on the other. Much swelling and uneasiness may arise from the presence of such a foreign body. In mumps, the submaxillary gland may participate, and may become swelled and painful.

Inflammation of the submaxillary gland may follow the irritation induced by a piece of dead bone in its neighborhood, or by a carious tooth or violent stomatitis. It is, however, the lymphatic glands which abound in the neighborhood of the submaxillary, which are most usually affected by such causes, and which simulate an affection of the submaxillary itself; and there is every reason to think that in not a few cases in which growths have been supposed to be seated in the submaxillary gland, calling for its excision, it has been the lymphatic glands which have been really involved, and which have been removed.

Cysts, adenoma, enchondroma, fibroma, sarcoma, lymphoma, and sarcolymphoma have been occasionally met with in the submaxillary gland. Paget declares that enchondroma is not as common in the submaxillary as in the parotid, and in this he certainly expresses the opinion of most, if not of all, surgeons. Submaxillary growths may attain a considerable size, pressing upwards into the floor of the mouth, and so causing embarrassment of function by their bulk; and even, in rare cases, compressing the pneumogastric and sympathetic nerves, and so causing, with other signs, dilatation of the pupil. The windpipe and œsophagus have also been pressed upon by these tumors.

Carcinoma is rare as a primary affection in the submaxillary gland, but it may extend from neighboring parts to this with other structures. It is, however, in the surrounding absorbent glands that this disease is most usually met with. Cancer causes much pain, and occasions a hard, fixed, irregular mass, which soon involves the skin and mucous membrane, and ends in foul ulceration. If it grows to any size, it produces pressure, and may at an early date arrest the flow of saliva from the affected gland. The absorbent glands quickly participate, and the whole of the parts are matted together in one mass. To remove a submaxillary gland so affected is no easy matter, and by the time the true nature of the disease is fully recognized and an operation determined on, it is usually hopeless as regards the saving of life. Jobert (de Lamballe[1]) and others, are said to have removed small cancerous tumors of the submaxillary through the mouth, without any external excision, but they must have been of trifling size, little adherent, and of a simplicity seldom encountered. The drainage would necessarily be bad, the difficulties great if the tumor were of any considerable bulk, and the advantage over the usual operation, below the jaw, difficult to discover. Unless the tumor has attained a large size, it is not a formidable operation to remove it by an external incision. The facial artery, which lies on or in the substance of the gland, is the only vessel which is likely to give trouble. It is best tied before the growth is moved from its bed. The hypoglossal and lingual nerves can be easily avoided, and the branch of the lingual artery which is cut can be readily secured.

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[1] Gaz. des Hôpitaux, 1849.

INJURIES AND DISEASES OF THE AIR-PASSAGES.

BY

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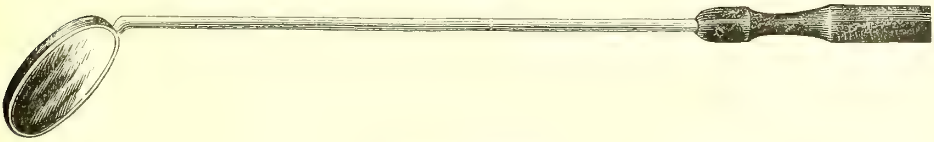
LARYNGOSCOPY.

LARYNGOSCOPY—inspection of the interior of the larynx—is effected by means of a small mirror so mounted as to be readily passed into the mouth and placed in a position which will reflect the image of the larynx. The same principle has long been employed by the dentist to obtain images of such portions of a tooth as are out of the line of direct inspection. It is to the experiments of Manuel Garcia, of London, a teacher of singing, that modern surgery is indebted for a knowledge of the laryngoscope;[1] it is to Prof. Czermak, of Pesth, that is due its reception into the medico-chirurgical armamentarium;[2] and it is to Prof. Tuerck, of Vienna, that medicine is chiefly indebted for copious clinical representations of its great usefulness in diagnosis and treatment.[3]

All that is needed to examine the larynx and adjoining structures, in the presence of a good light, is a good glass mirror, mounted on a rod firm enough to resist being bent by the muscular action of the soft palate. A circular mirror one inch in diameter (Fig. 1020) will suffice for most purposes in the adult. Smaller mirrors are sometimes needed with adults, and almost always with children.

Fig. 1020.



Laryngoscopic mirror.

The position of the mirror in the mouth, and the general features of the image of the normal larynx as seen in it, are fairly represented in Fig. 1021. The manipulation of the laryngoscopic mirror may be briefly described as follows: The mouth of the patient being well illuminated by natural or artificial light, direct or reflected as may be most convenient at the moment, the patient is directed to open his mouth, to put out his tongue as far as possible, and to prevent his tongue from slipping back by holding it in a fold of a handkerchief or napkin (Fig. 1021). The surgeon, with his mirror in hand much as he would hold a pencil (Fig. 1022), warms the glass over the flame of an alcohol lamp or gas jet, to prevent condensation of the breath on its surface, and then passes the mirror into the mouth, reflecting surface downward, and rests it against the soft palate, which he lifts slightly with the uvula on the back of the mirror. The reflecting surface now presents itself obliquely forward and downward, and shows an image of the parts in front of it and below. By moving the mirror gently, the image is changed from point to point until the inspection has been completed. With a steady hand and a little practice, the larynx can be thus examined at once in the great majority of instances. Repeated attempts are necessary, at intervals of a few moments of rest, with nervous subjects, and in cases of hypersensitiveness of the parts from disease. For the minute details of manipulation the reader must be referred to manuals of laryngoscopy and of diseases of the throat.

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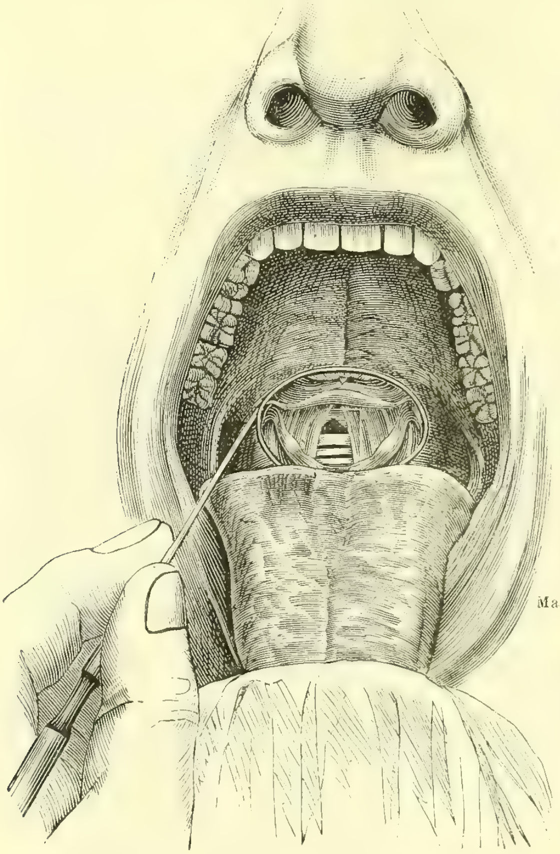
[1] Physiological Observations on the Human Voice. Proc. Royal Soc., vol. vii. No. 13, p. 399. London, 1855.

[2] Wien med. Woch., No. 13, März, 1858; Der Kehlkopfspiegel und seine Verwerthung für Physiologie und Medizin. Leipzig, 1860.

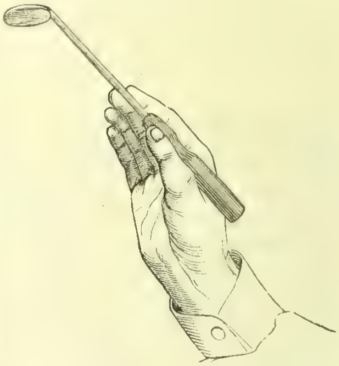
[3] Klinik der Krankheiten des Kehlkopfes und der Luftröhre. Wien, 1866.

Fig. 1021.



Laryngoscopic mirror in position. The tongue extended, and held with a napkin.

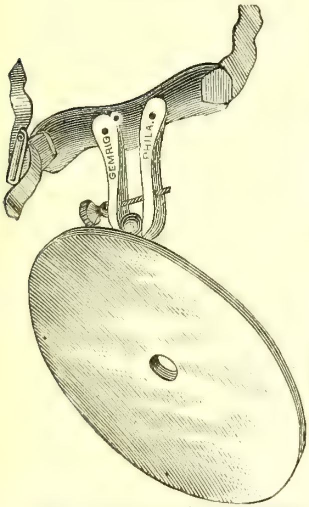
Fig. 1022.



Manner of holding a laryngoscopic mirror.

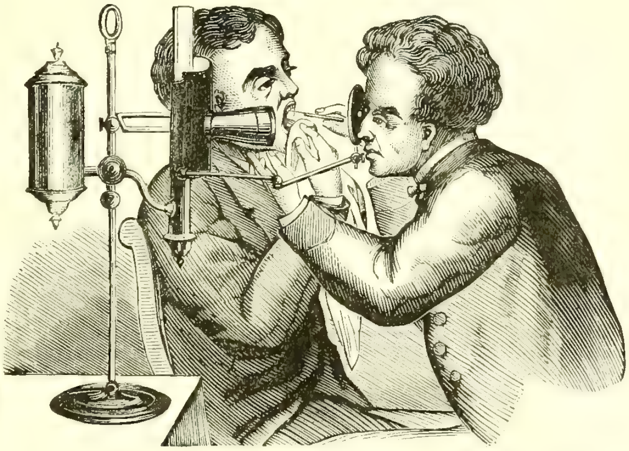
When examinations are made with daylight, the parts appear in their true colors, which are much paler than the colors produced by artificial light. When direct daylight cannot be used, the diffuse daylight may be concentrated upon the interior of the mouth and throat by means of a concave reflector similar to those used in ophthalmoscopy (Fig. 1023), which may be held in the hand, or may be attached to the head. The same kind of reflector is used with artificial light, a combined illumination practised more frequently than any other, and then the reflector may be conveniently attached to either a lamp (Fig. 1024) or a gas-bracket. Various lanterns, or light-concentrators, are used for illuminating purposes, but a good naked gaslight answers admirably, and a coal-oil light is still more satisfactory. The lanterns, whether for coal-oil, gas, oxy-hydrogen, or electric lights, are not needed for ordinary purposes. The brightest light available is sunlight, direct, or reflected from the surface of a plane mirror.

Fig. 1023.



Perforated reflector for laryngoscopy, with band for attachment to head.

Fig. 1024.



Laryngoscopy by reflected artificial light. Method of Tobold. (Tobold.)

The image of the structures thus to be inspected by laryngoscopy requires some little preliminary study on the normal subject, or on the exsected larynx, to be fully comprehended; for it appears in a position nearly vertical, while the natural plane is much more horizontal. Then, too, there is an apparent antero-posterior reversement of position, with maintenance of the actual lateral relations of left and right.

The structures which can be inspected laryngoscopically are, from before backward and downward: The posterior portion of the base of the tongue; the posterior surfaces of the anterior palatine folds, and their attachment to the sides of the base of the tongue; the lateral ligaments connecting the tongue with the hyoid bone; the ligaments connecting the tongue with the epiglottis, together with the lingual sinuses on either side of the middle glosso-epiglottic ligament; the tonsils; the posterior palatine folds; the ligaments connecting the epiglottis with the hyoid bone; the epiglottis, on both lingual and laryngeal surfaces; the aryteno-epiglottic folds forming the lateral borders of the entrance into the respiratory portion of the larynx; the arytenoid and supra-arytenoid (Santorini) cartilages; the posterior or arytenoidal vocal processes, extending into the structure of the vocal bands; the base and sometimes more of the cuneiform (Wrisberg) cartilages; the laryngo-pharyngeal sinuses between the wings of the thyroid cartilage and the soft lateral walls of the laryngeal tube; the posterior wall of the pharynx down to its transition into the œsophagus; the posterior wall of the larynx down to where the pharynx merges into the œsophagus; the supra-glottic portion of the interior of the larynx; the vocal bands (true vocal cords), the laryngeal ventricles (Morgagni) above them, and the ventricular bands (false vocal cords) above the ventricles; the infra-glottic portion of the cavity of the larynx to a variable extent, and the internal face of the anterior portion of the thyroid cartilage, crico-thyroid membrane and cricoid cartilage; the anterior portion of the trachea in variable extent, clear down to its bifurcation under favorable anatomical relations; a portion of the interior of the right bronchus under exceptional normal conditions; and more or less of the posterior wall of the trachea.

Wounds and Scalds of the Larynx and Trachea.

Wounds of the larynx and trachea occur as results both of external and internal injuries. Wounds from external injuries usually, but not invariably, implicate the integument by solution of its continuity. They are usually attended by extensive hemorrhagic extravasations into the abundant loose connective tissue. They are frequently complicated by fractures of the cartilages. They are occasionally complicated by wounds of the great cervical bloodvessels and nerves. Wounds from internal injury almost always implicate the mucous membrane in the first instance; in rare instances they may penetrate the cartilage; even a wound of the carotid artery has been known to occur in this manner.

Wounds of external origin present themselves in the usual varieties of contused, punctured, incised, lacerated, and gunshot wounds. Wounds of internal origin present themselves mostly as lacerated, but occasionally as punctured wounds. They are usually the result of injury by a foreign body in the air-passage.

Scalds or burns may be caused by hot or caustic fluids swallowed accidentally or designedly, or by flame or hot air inhaled from burning buildings or ships.

I. Wounds of the Larynx and Trachea.

Wounds of External Origin.—*Contused wounds of the larynx* are usually produced by intentional blows upon the throat with the fist or a weapon, by kicks from men or beasts, by accidental blows from hard objects, or falls upon them, or by attempts at strangulation, whether with hands, with cloth, or with rope. They are liable to cause considerable extravasations of blood into the submucous and intermuscular connective tissue. In some instances the injury is sustained by the soft parts only. Some cases are complicated with fracture of the cartilage—simple, or even comminuted—occasionally the cricoid, but more frequently the thyroid. These fractures may be anterior or lateral, and are usually vertical, or nearly so.[1] Other complications comprise rupture of the ligaments and connecting membranes of the different components of the laryngeal skeleton; rupture or laceration of the vocal bands, mucous membrane, and other soft tissues; fracture of the cornua of the hyoid bone; dislocation of an arytenoid cartilage; and contusion, rupture, or other injury to the trachea.

Contused wounds of the trachea occur from the same class of causes as similar wounds of the larynx. They are usually associated with rupture of one or more intercartilaginous ligaments, or with rupture of the trachea from the cricoid cartilage. Sometimes they are associated with longitudinal fractures of one or more rings; and sometimes with comminuted fractures, as when the result of crushing violence.[1] Sometimes they are associated with laceration or rupture of the membranous wall, either with or without perforation into the œsophagus. Hemorrhagic extravasations may be very extensive. In most instances these wounds are associated with wounds of the larynx, similar or still more severe.

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[1] See Fractures.

Punctured wounds of the larynx are usually accidental, as from falls upon pointed objects. Legouest[2] has reported one in which the tine of a pitchfork perforated the larynx from right to left. Sometimes they are the result of homicidal attacks with sharp or pointed weapons; occasionally they are suicidal. Modern military records seem to furnish few examples of bayonet wound of the air-passage. Only nine bayonet or sabre-wounds of the neck are recorded in the History of the War of the Rebellion, and in none of these had the air-passage been implicated. Durham, however,[3] relates the case of a patient under his care in Guy's Hospital, London, whose larynx had been wounded by a bayonet during this war. According to the same author, punctured wounds through the thyroid cartilage occasionally penetrate between the vocal bands, or injure one or both of them; œdema of the glottis(?) ensuing almost invariably, and producing death by suffocation. A case is quoted from Sir Charles Bell in which suffocation from exuberant granulations ensued some months after a wound in this situation, inflicted with a penknife. The wound in the integument may be trifling. Emphysema is a frequent complication, and may produce severe dyspnœa.

Punctured wounds of the trachea are due to the same class of causes as are punctured wounds of the larynx. Beach[4] has reported a case of perforation of the trachea by the tine of a pitchfork. Such an injury from a sword has been recorded by Paré,[5] and one from the point of a closed pair of scissors, by W. F. Atlee.[6] Three instances of penetration of the trachea in injecting bronchocele have been mentioned by Mackenzie,[7] in one of which persistent hæmoptysis ensued. Emphysema of the neck is quite a common result in punctured wounds of the trachea, and general emphysema may reach alarming proportions within a few hours.[8]

Incised wounds of the larynx are more frequent than those of all other varieties together. Surgical wounds for operative purposes will not be discussed in this connection. Incised wounds may involve not only the integument and the structures of the air-passages, but also the muscles, bloodvessels, nerves, submaxillary glands, and tongue. Occasionally accidental, as in falling upon a sharp object, such as a fragment of glass or crockery, and sometimes due to homicidal attacks, most wounds of this class are suicidal. In some wars they are produced by sabre-cuts. (Paré, Legouest.)[9] It has been estimated statistically that of 4595 suicides in France, 125 had cut their throats;[10] and that of 6696 cases of suicide in England, between 1863 and 1867, 1235 were cases of cut-throat.[11]

Quite a large proportion of suicidal wounds are seen in insane subjects and in incarcerated criminals. The sane and unconfined suicide usually uses a razor or a knife; but the insane suicide and the prisoner, from whom cutting implements are withheld, often construct weapons out of spoons or forks, fragments of glass, or other available objects.

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[1] See Fractures.

[2] Horteloup, Plaies du larynx, de la trachée et de l'œsophage, p. 51. Paris, 1869.

[3] Holmes's System of Surgery, vol. i. p. 689. Am. ed., 1882.

[4] New York Med. Jour., March, 1877, p. 302.

[5] Œuvres completes, éd. par Malgaigne, t. iv., liv. 8, chap. xxx.; Mackenzie, Diseases of the Throat and Nose, vol. i. p. 540. London, 1880.

[6] Am. Jour. Med. Sciences, April, 1878, p. 439.

[7] Op. cit., p. 540, note.

[8] Beach, loc. cit.

[9] Horteloup, op. cit., pp. 53–55.

[10] Brierre de Boismont, Du Suicide. Paris, 1856.

[11] Durham, op. cit., vol. i. p. 684.

The individual who determines to commit suicide by cutting his throat, has usually become impressed with the erroneous popular belief in the necessary fatality of an extensive wound into the windpipe; while the source of immediate danger to life really resides in division of the cervical bloodvessels, the elasticity and mobility of which often protect them from direct injury. As a rule, too, the head is bent backward, to render the windpipe more prominent as the stroke is made. Hence, the sterno-mastoid muscles are advanced, and the large bloodvessels are pushed behind the ordinary range of the knife, especially if the cut be made high up; and thus the main portion of the deep wound is in the air-passage. When, however, the suicide, like Lord Castlereagh, who thrust a penknife through his carotid artery, is familiar with the anatomy of his neck, or when in his excitement he makes a sweeping cut, the great cervical blood-vessels are severed in the incision, and death takes place by hemorrhage and not by reason of any opening that has been made into the air-passage. Sometimes, however, hemorrhage into the air-passage produces speedy death by suffocation. The infrequency of wounds of the great vessels is furthermore attributed to the resistance of the cartilages, which prevents deep incision at the level of the larynx; and to spasmodic contraction of the sterno-cleido-mastoid muscles when the cut is at a lower level (Durham); while when the trachea is severed, the sudden escape of air from the lungs is supposed to deprive the arm of the full support of the thoracic muscles, so that the arm falls before the stroke has been completed. (Hinton, cited by Durham.) The wound of the integument is usually from left to right, and more obliquely downward than transverse, the greater portion of the cut being upon the left side when the right hand has been used, as is the rule.

The size of the external wound varies from little more than a puncture to a length of several inches, even reaching from one sterno-cleido-mastoid muscle to the other. As a rule it is much larger than the wound in the air-passage, but sometimes it is much smaller, as in a case reported by Fine,[1] in which but a small external wound was made with the point of a penknife, while the thyroid cartilage was divided into eight portions.

Incised wounds of the neck, above the hyoid bone, do not implicate the larynx, although they may penetrate the air-tract by opening into the pharynx or into the mouth. Nevertheless, death by suffocation may ensue from occlusion of the larynx by the posterior portion of the divided tongue.[2]

The hyo-thyroid membrane is the most frequent seat of lesion. Wounds of this membrane, although, anatomically, wounds opening into the pharynx, must be discussed in connection with wounds of the larynx, because the epiglottis is frequently severed in the incision, sometimes in its free portion and sometimes at its attached portion. If not severed it is often wounded. In some instances the epiglottis escapes the cut, and the upper portion of the larynx is exposed to view uninjured. In a case of this kind, in an aged subject but recently (April, 1884) under observation in consultation with my colleague Dr. James Collins, at the German Hospital, Philadelphia, the section had divided the tongue, the sterno-cleido-mastoid muscles, both submaxillary glands, and the pharynx to within an inch of its entire circumference. In

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[1] Jour. de Méd., Chir., Pharm., etc., 1790; quoted by Fischer (Pitha und Billroth's Handbuch, Bd. iii. 1 Abth. 3 Lief. S. 101).

[2] See Durham's case, Holmes's System of Surgery, vol. i. p. 687.

some instances the hyoid bone and the tongue are severed from the larynx; and the upper fragment of a still attached epiglottis may be seen in the upper segment of the wound, and its intra-thyroidal portion in the lower. The gaping in these wounds is very great. The extent to which the pharynx is severed may comprise its entire circumference, the knife penetrating a vertebra.[1] In a case seen by myself in the hospital practice of Dr. R. J. Levis, of Philadelphia, less than half an inch of the posterior pharyngeal wall had escaped division.

Cuts through the thyroid cartilage may wound the vocal bands. They seldom penetrate the entire cartilage. Sometimes they fail to reach the mucous membrane, so that the air-passage is not opened at all. Cuts through the crico-thyroid membrane may sever the larynx completely.[2] Cricoid cartilage[3] and pharynx may be injured likewise. Sometimes one or both supra-arytenoid cartilages, or even the arytenoid cartilages, are severed or wounded. The crico-tracheal membrane is very rarely the seat of the wound. The resistance being slight, wounds here generally sever the trachea from the larynx.

That the larynx is wounded more frequently than the trachea, seems to be the individual opinion of surgeons as drawn from personal observations. Nevertheless, a systematic compilation by Sabatier[4] gives the trachea as the seat of injury in 22 instances out of 45, or practically in one-half the cases, the crico-thyroid membrane having been severed in 13 and the thyroid cartilage in 10. Durham[5] gives the trachea as the seat in 41 out of 158 unselected cases of penetration of the air-passages, the situation of the wound having been above the hyoid bone in 11 cases, through the hyo-thyroid membrane in 45, through the thyroid cartilage in 35, and through the crico-thyroid membrane in the remaining 26.

According to Malgaigne,[6] the larynx is severed in young subjects only, and for the reason that they can throw their heads further back than old persons, in whom the suicidal injury is consequently more frequent in the trachea. If this be the rule, it is not without many exceptions; for wounds through the thyro-hyoid membrane at least are not uncommon in aged subjects.

When the epiglottis, or a portion of the arytenoid or supra-arytenoid cartilage, has been severed, there is liability to impaction of the fragment between the vocal bands or above them; an accident that may take place within a brief interval,[7] or not until after some hours or a few days. Suffocation may ensue in such instances.[8] Hence any movable fragment which might induce such an accident should be promptly excised, for it can rarely be safely secured for any length of time by stitching.

If the suicide has made several cuts in his neck, as shown by a jagged wound of the integument, portions of the cartilages may have been hacked into a number of pieces, some of which may hang loosely. Under such circumstances it becomes still more imperative to remove all fragments. The immediate danger of death by suffocation from hemorrhage into the air-passage, or from occlusion by blood-clots, is much greater in multiple wounds of this sort, than in wounds by a single stroke. The like danger is greater in wounds of the trachea than in wounds of the larynx, because of simultaneous severance of thyroidal vessels or of the thyroid body.

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[1] Fischer, Pitha und Billroth's Handbuch, Bd. iii. 1 Abth. 3 Lief. S. 101.

[2] Hennen, Principles of Military Surgery, 3d ed. p. 368. London, 1829; Gross's System of Surgery, 6th ed. vol. ii. pp. 315 and 316. Philadelphia, 1883.

[3] Stokes, quoted by Gross (op. cit., vol. ii. p. 315).

[4] Horteloup, op. cit., p. 16.

[5] Holmes, op. cit., vol. i. p. 687.

[6] Horteloup, op. cit., p. 17.

[7] Houston, Dublin Hospital Reports, vol. v. page 315; cited by Ryland, Durham, and others.

[8] See cases narrated by Sir Chas. Bell (Surgical Observations, vol. i. p. 44), Dr. Wm. Stokes, and Prof. S. D. Gross (op. cit., vol. ii. p. 315).

Œdema of the larynx sometimes follows incised wounds, especially those in which the upper portion of the larynx has been uncovered by division of the hyo-thyroid membrane. The action of the atmospheric pressure in rolling the œdematous aryteno-epiglottic folds inward and downward at each inspiration, is beautifully demonstrated in these instances, confirming Sestier's antelaryngoscopic theory of the mechanism in some cases of suffocation in œdema of the larynx.

Emphysema occurs in some cases of incised wound, especially when the wound in the integument does not open directly upon the wound in the air-passage. This emphysema may spread not only over the neck, face, and thorax, as is not infrequent, but likewise over the entire abdomen, down into the scrotum, or even into the mediastina or into the interior of the larynx.[1] It is most likely to occur in cases where the surgeon has been too assiduous in approximating the edges of the external wound.

Incised wounds of the trachea are due to causes similar to those of incised wounds of the larynx. They usually occupy the upper portion of the tube. They are often associated with wounds of the thyroid gland. They are liable to serious complication by suction in of the soft parts, so as to occlude the air-passage and threaten suffocation. Durham[2] refers to a fatal case of this kind related by Casper, and to a case narrated by Richet, in which the œsophagus projected forward and became interposed between the cut ends of the divided trachea.

The wound usually implicates the anterior or cartilaginous portion of the trachea only, and occupies one or more rings, passing obliquely from left to right. Sometimes the tube is divided in its entire extent, exposing the intact or wounded œsophagus, as may be; and then the lower end may become greatly retracted—so much so, if the wound be low down, as to become almost hidden at each inspiration. Durham[3] cites a case from Richet,[4] in which the trachea had been divided obliquely through four or five of its rings, the separation between the two portions measuring more than two inches, with an increase of about half an inch additional during inspiration, and the lower part plunging down almost into the mediastinum. The œsophagus is very liable to suffer injury in case of complete division of the trachea.

Hemorrhage is often quite copious from incised wounds of the trachea, especially if the thyroid veins or the thyroid gland have been wounded. The danger from entrance of the blood into the air-passage is greater than in similar wounds of the larynx. The laryngeal nerves are sometimes wounded (Larrey), but as a rule neither nerves nor great bloodvessels are injured, even though the sterno-mastoid be severed and the carotid artery exposed.

Emphysema occurs as in incised wounds of the larynx, and much more frequently because of the small size of the wound and the corresponding difficulty in the escape of the air.

Lacerated wounds of the larynx, other than gunshot, are very infrequent. They result from falls, kicks, blows from falling objects, and crushing violence by machinery and otherwise. They are almost always accidental. They are sometimes associated with wounds of the pharynx, as in the case of a fall on broken crockery, which recovered under the care of Mr. Bryant.[5] Sometimes they are associated with comminuted fracture. They may be accompanied by laceration of the trachea, as in an injury from the kick of a horse, where a rupture extended through the thyroid and cricoid cartilages, and continuously through the first tracheal ring.[6]

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[1] Horteloup, op. cit., pp. 53, 71; Durham, op. cit., vol. i. p. 688.

[2] Op. cit. [3] Op. cit. [4] Gaz. des Hôp. 1855, p. 35.

[5] Brit. Med. Jour., Jan. 26, 1884, p. 164.

[6] O'Brien, Edinb. Med. and Surg. Journ., vol. xviii.; quoted by Ryland and others.

Lacerated wounds are sometimes wholly internal, although caused by external violence.

Lacerated wounds of the trachea are more common than lacerated wounds of the larynx. They occur most frequently in the form of rupture between cartilage and ligament. Like lacerated wounds of the larynx, they are most frequently the result of various local injuries, such as falls, blows, kicks, and crushes. Counter-pressure may be an occasional cause, as in a case reported by Godlee,[1] in which the trachea of a child was split, front and back, immediately above the bifurcation, in consequence of the passage of a cart-wheel over the chest—the third, fourth, and fifth ribs sustaining fracture on the right side at their point of greatest convexity.

Causes of non-surgical origin occasionally produce rupture or laceration of the trachea, such as cough in croup[2] and bronchitis,[3] chiefly in children; violent inspiratory efforts in dyspnœa from obstruction or compression;[4] and violent expiratory efforts in parturition, or even in defecation. Rupture of the softened trachea may result from the pressure of an abscess, an aneurism, or a morbid growth.

In cases more strictly surgical in origin and character, the laceration or rupture may be associated with fracture of the cartilages. It often occurs independently.

The rupture occurs most frequently between two of the upper rings, or between the upper ring and the cricoid cartilage. In the latter case, the trachea may recede quite a distance from the larynx. An instance is recorded by Mr. Long,[5] in which the trachea had become separated from the larynx for a distance of about two inches, as demonstrated during a tracheotomy which saved the life of the patient. The violence had been very great in this instance, the neck having been caught by the coupling-irons of two railway coaches. A case of complete rupture of the trachea from the larynx, the result of a kick from a horse, is recorded by Robertson.[6]

Gunshot wounds are most frequent in military practice. Nevertheless, their small proportion seems sometimes remarkable, the records of several extensive wars of the present generation not presenting a single example. The resiliency and mobility of the larynx and trachea doubtless deflect many balls, so that the air-tube, though struck, is not penetrated.[7] The texture of the beard, and the position of the lower jaw, especially in the position of firing a gun, are regarded as additional factors in protection. The French contingent in the Crimean war[8] reported but one wound of the larynx, and that a gunshot wound, out of a total of 28,401 wounds, of which 460 implicated the neck. The English contingent[9] reported eight wounds of the larynx, pharynx, and œsophagus, out of 147 neck-wounds. Five of these cases, and an additional one, are related by Mr. Longmore in Holmes's System of Surgery. In Demme's Record of the Italian War of Independence, in 1859, there is no mention of wounds of the larynx, although there were 170 neck-wounds in the Austrian army, and 187 in the forces of the allies. Löffler's report of the Schleswig-Holstein war, in 1864, is said to be equally silent as regards the larynx, the number of neck-wounds being 48 out of 2355 among the Prussians, and 26 out of 1203 among the Danes. In the Austro-Prussian war of 1866, Biefel reports two wounds of the larynx and trachea out of 382 cases, and Maas reports one out of 212. As regards the last Franco-Prussian war, neither Bussenius nor MacCormac reports a single wound of the air-passage, but Beck reports nine cases out of 83 neck-wounds. Fischer reports three cases out of 15 neck-wounds, and Kirchner reports one out of 32. Witte, from whom the above references have been culled, mentions other wars, the statistics from which are valueless in the present connection.

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[1] Med. Times and Gaz., December 12, 1874, p. 675.

[2] Latour, Manuel sur le Croup. Orleans, 1808; Voss, New York Med. Jour., Jan. 1860, p. 37.

[3] Bredschneider, Casper's Wochenschrift, S. 261. 1842; Lefferts, Medical Record, Nov. 25, 1882, p. 599.

[4] Marshall, cited by Gross (op. cit., vol. ii. p. 317).

[5] Brit. Med. Journ., July 26, 1856.

[6] Lancet, September 6, 1856.

[7] See case of Hooper, mentioned by Gross (System of Surgery, 6th ed. vol. ii. p. 315); and cases in the Medical and Surgical History of the War of the Rebellion, Part First, Surgical Volume, p. 406.

[8] Chenu, cited by Witte (Arch. f. klin. Chir., Bd. xxi. S. 184. 1877).

[9] Medical and Surgical History of the British Army, 1854–6; Witte, loc. cit.

None of the statistics yet cited approach in completeness those given in Surgeon Otis's encyclopædic records of the War of the Rebellion.[1]

Gunshot wounds of the larynx and trachea comprised 2.2 per cent. of the gunshot wounds of the neck that came under treatment during that war. In a few, the larynx and trachea were both involved; in others, the air-passages together with the pharynx or œsophagus. The trachea was less frequently injured by small projectiles than the larynx, and was most frequently wounded in its posterior, membranous portion. Ample evidence was afforded that missiles are diverted from their course on impact with the trachea. Out of 4895 cases of gunshot wound of the neck, without known injury to the cervical vertebræ, 41 involved the trachea, with 21 deaths, the result in one case being unknown; 30 involved the larynx, with 10 deaths, and 10 results unknown; 4 involved both trachea and larynx, with no death; 2 the trachea and pharynx, with no death; 2 the trachea and œsophagus, both fatal; 1 the larynx and œsophagus, the patient recovering; 2 the pharynx and larynx, both fatal.[2] Only four specimen-preparations are preserved in the U. S. Army Medical Museum—Nos. 648, 697, 1440, and 2021.

Gunshot wounds are mostly caused by bullets; some, by fragments of shell. They are usually complicated with contusion and laceration of the soft parts, and with comminuted fracture of the cartilages. Contusion, effusion, and suppuration of the interior may take place, although the ball does not penetrate the larynx.[3] Fractures from gunshot wound have been recorded, without destructive wound of the integument.[4]

Whether the bullet shall pass through the larynx, as it does in some instances, or whether it shall remain impacted, as occasionally happens, depends upon the distance travelled by the missile, the tissues traversed before it impinges upon the larynx at all, the part struck, and the position of the individual and the part at the moment of injury; but Preparation 1440, U. S. Army Medical Museum, shows an imitation of the battered conoidal ball which lodged in the upper portion of the right wing of the thyroid cartilage, after having shattered the inferior maxilla to the right of the symphysis. The missile may lodge elsewhere in the tissues, after traversing the larynx. In a case reported[5] by Dr. Daly, of Pittsburg, at the meeting of the American Laryngological Association in 1884, the bullet was removed from within the sheath of the subclavian artery on the side of exit. Large portions of the anterior portion of the larynx or trachea are occasionally destroyed in this manner. Dr. Chisolm[6] mentions that several instances occurred among the Confederate forces, in the late war in the United States, where the larynx had been carried away. Sometimes the destruction is confined to the perforation made by the ball.

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[1] Med. and Surg. History, etc., Part First, Surgical Volume, p. 406.

[2] Op. cit., Part Third, Surgical Volume, p. 688.

[3] See cases recorded in Med. and Surg. History of the War of the Rebellion, Part First, Surgical Volume, p. 404.

[4] Medical and Surgical History of the British Army, 1854–56, cited by Witte (loc. cit., S. 484): Wales, Am. Journ. Med. Sci., Jan. 1867, p. 269.

[5] New York Med. Jour., July 12, 1884, p. 29.

[6] Cited by Otis, Med. and Surg. History, etc.

Sometimes the epiglottis is carried away; sometimes it is split or simply wounded. The missile sometimes wounds the larynx after having passed through the face, the chest, or the upper extremity; and thus fractures of the jaw, clavicle, or humerus, and lacerations of the face, neck, and chest, become associated with gunshot wounds of the air-passages.[1]

The hemorrhage in these cases is usually much less than in those of incised wound, but the syncope therefrom perhaps more frequent and more protracted.

The comparative infrequency with which the great cervical bloodvessels and nerves sustain injury, is attributed to their great mobility and elasticity. No mention of injury to the great bloodvessels or nerves is made in the description of any of the four specimens of gunshot wound of the larynx in the U. S. Army Medical Museum,[2] while the absence of such injury is alluded to in the description of two. (Specimens 648 and 1440.)

WOUNDS OF INTERNAL ORIGIN may be lacerated, contused, or punctured. They are usually produced by foreign bodies with hard, sharp, and jagged edges, such as coins, fish-hooks, needles, nails, splinters, fish and meat bones, and pieces of glass. These wound the epiglottis, or penetrate or tear the larynx or the trachea.[3] They may excite inflammatory tumefaction with resultant œdema, or may irritate the nerve-tracts and excite spasm of the glottis, and may thus necessitate tracheotomy in either case.

Witte[4] narrates a case, reported by Surgeon Cotting, in which a dart was inhaled into the larynx, point upward. The continuous efforts of the injured lad to cough the foreign body out, gradually drove the point of the nail through the thyroid cartilage into the sheath of the great bloodvessels, and death followed in consequence of a wound of the carotid artery.

Awkward and incautious attempts at intra-laryngeal surgery are responsible for a certain number of contused, lacerated, and even incised wounds. Hemorrhagic œdema may be instantaneous after contusions and lacerations. The wounds resulting from a proper use of the knife, forceps, or galvano-cautery, are to be discussed in connection with the affections requiring such treatment.

Ziemssen[5] relates a fatal case of œdema from spearing of the walls of the laryngeal ventricle by the rib of a tobacco leaf, and another sudden death from the same cause, after a wound produced by a pointed piece of bone. Cases of wound from foreign bodies are sometimes promptly fatal by suffocation.

In occasional instances, the injury has occurred by emesis during drunkenness, or in the course of cerebral disease, the soup or gruel vomited having contained hard substances which thus entered the air-passage.[6] Beigel[7] reports the case of a twenty-four year old female, with rupture of both vocal bands from their intersections at the arytenoid cartilages, and transverse rupture of the left band in addition, from continuous crying when a baby.

Inflammation follows the injury. Œdema may ensue, threatening suffocation, or spasm of the glottis with similar manifestations.

Symptoms of Laryngeal and Tracheal Wounds.—The symptoms of a wound of the larynx or trachea are usually sufficiently evident, save in some instances of contused wounds, in which the special manifestations do not promptly follow the receipt of the injury.

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[1] For cases illustrating these points, see Catalogue U. S. Army Medical Museum, Surgical Section, p. 477. Washington, 1866. (Specimens 697, 1440, and 2021.)

[2] Op. cit.

[3] See Foreign Bodies.

[4] Arch. f. klin. Chir., S. 193. Berlin, 1877.

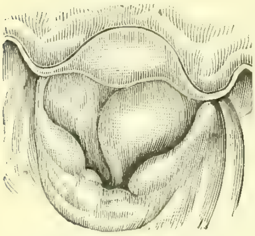
[5] Cyclopædia of Practical Medicine, vol. xii. p. 80.

[6] Witte, loc. cit.

[7] Berlin. klin. Woch., 1868, S. 394; cited by Witte.

Contused Wounds give rise to one or more of the following group of symptoms: Bruise or other external evidence of injury; severe pain or tenderness on motion of the parts and on deglutition; dysphonia or aphonia; cough, with bloody expectoration; spasm of the glottis; spasmodic, opisthotonic retraction of the cervical muscles;[1] tumefaction of the integument. Dyspnœa is but slight, unless there has been tumefaction, effusion, or laceration and hemorrhage internally—circumstances under which apnœa may ensue. Insensibility from shock is noticed as a prominent symptom in some cases. Laryngoscopically, the evidence of congestion and of hemorrhagic effusion may be quite marked, as in a case reported by Dr. Packard,[2] of Philadelphia. (Fig. 1025.)

Fig. 1025.



Laryngoscopic picture in contusion of the larynx. (Packard.)

Punctured wounds give rise to threatening apnœa from accumulation of blood in the air-passages. Punctured wounds of the trachea may give rise to hemorrhage internally, as shown by hæmoptysis, even though there be no hemorrhage externally. Emphysema of the neck is quite a prominent symptom, and may occasion serious dyspnœa. Sometimes it extends to a great distance from the seat of the external wound. In the efforts at expectorating, blood-clots may become lodged in the air-passage so as to occlude it. Such a clot has been known to become impacted in a ventricle, and to form there a valve preventing ingress of inspiratory currents of air. In either event, symptoms of suffocation will ensue. Pain or tenderness, cough, dyspnœa, and dysphonia or aphonia, exist in some instances as in wounds of the air-passages in general.

Incised wounds occasion various combinations of symptoms according to the extent of the wound, its location, the injury to the surrounding tissues, and the age and physical and mental condition of the individual. The main objective symptoms are: first, the gaping external wound, exposing the muscular and vascular tissues of the neck, the air-passage, and the pharynx or œsophagus, as may be; and, secondly, hemorrhage, and the escape of mucus, blood, and saliva, through the wound as well as from the mouth. Fluids swallowed will escape likewise in some instances, unless the parts are supported externally during deglutition. In a case of suicidal wound seen by myself, this was the first symptom to attract attention, hemorrhage having ceased, and the divided parts being concealed by a beard. Emphysema is usually a later manifestation than those detailed. The edges of the wound gape little or much, according to its location and the depth of the section. They are but slightly separated when the incision into the larynx or trachea has been shallow or incomplete, while they may be separated to a distance of several inches, even the breadth of a hand, when the section has been a deep or complete one. In wounds through the thyro-hyoid membrane, or the superior portion of the thyroid cartilage, the upper segment may recede to the very jaw. In wounds through the trachea, the lower segment may recede behind the sternum.

The hemorrhage is usually copious, even though the great cervical blood-vessels be uninjured. Dyspnœa or apnœa sometimes results at once, from entrance of blood into the air-passages; both much more frequently with small wounds than with large ones. The hemorrhage often ceases by syncope. Secondary hemorrhage, however, is to be expected on reaction, and this, again, may suffocate the patient, especially if the edges of the external wound have been stitched meanwhile in close apposition.

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[1] Stromeyer, Handbuch der Chirurgie, Bd. ii. S. 309. Freiburg, 1865.

[2] Archives of Laryngology, vol. i. p. 57. 1881.

Suffocation is not imminent from hemorrhage alone; but other causes may produce it, varying according to the location and character of the wound. Thus it may be due to occlusion of the larynx by the base of a divided tongue, or by a divided or detached epiglottis; or to occlusion of some part of the air-tube by impacted fragments of severed or partially severed cartilage or other structure. Even the ball itself, in cases of gunshot wound, has been known to produce this symptom by its arrest in the air-passage. In case of threatening apnœa from loose fragments of cartilage, distinct flapping of the fragment may be recognized, as in the case under the care of Sir Charles Bell which has already been alluded to.

The subjective symptoms of incised wounds are pain, cough, spasm, dysphagia or aphagia, dyspnœa or threatening apnœa, dysphonia or aphonia.

Debility of voice sometimes results from direct injury to the vocal bands in wounds through the thyroid cartilage. In wounds above the vocal bands, the voice will be lost while the edges of the external wound are allowed to gape, and will be restored when they are approximated by bending the head, or when the external orifice is occluded with the hand or with a compress. Dysphagia and aphagia are usually due to section of the pharynx or œsophagus, food and drink escaping by the external wound, or passing into the air-passage. Cough is due to direct access of air, and access of mucus, blood, and saliva. Expectoration is usually difficult, and apnœa may result from this cause. Intense thirst is an occasional symptom, and may be very prominent, as in a suicidal case mentioned in the Medical and Surgical History of the Rebellion,[1] which required the use in a peculiar way of twenty gallons of water daily, to assuage it. Some water was sucked through a tube attached to a reservoir, and apparently swallowed; and then a quantity was allowed to pass through the pharynx and escape by the wound.

Lacerated wounds present much the same symptoms as incised wounds. The hemorrhage is much less as a rule; the danger from suffocation by blood or blood-clots, greater.

Gunshot wounds, complicated as they often are by serious contusion, may present the symptoms of contused wounds in addition to pain, emphysema, escape of fluids from the wound, aphonia or dysphonia, cough, expectoration, etc., as detailed in connection with the symptoms of incised wounds. The impact of the ball sometimes produces a local numbness, or a numbness extending into the arm, indicative of implication of the spinal accessory nerve. Torticollis is mentioned in military records as quite frequent. Contusion or laceration of the pneumogastric nerve or of its laryngeal twigs, may produce paralysis or spasm of the laryngeal muscles, entailing aphonia on the one hand or stridor on the other, from that cause, independently of any mechanical result of the direct lesion in the tissues. Stridor may be due, likewise, to paralysis of the dilating muscles of the glottis. Internal injury of the laryngeal structures is quite frequent, and aphonia may result from such direct injury to the vocal bands. Mr. Erichsen has called attention to a special loss of sensitiveness of the glottis, permitting the passage of food and drink into the air-passage, a condition recognized by S. D. Gross,[2] McGuire,[3] and other writers, as a characteristic symptom of gunshot wounds of the larynx.

The primary hemorrhage is much less than in incised wounds; but the secondary hemorrhage may be more profuse, and may suffocate the patient by inundating the air-passage or by occluding it with clots. Such accidents are particularly to be feared after too great assiduity in closing the external wound. They are most to be apprehended after wounds of the trachea, in which injuries may have been sustained by the thyroidal vessels and the thyroid body.

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[1] Op. cit., Part First, Surgical Volume, p. 409.

[2] Op. cit.

[3] Holmes's System of Surgery, Am. Ed. vol. iii. p. 484.

The inflammatory swelling of the tissues during the process of repair may compress the air-passage externally, or encroach upon it internally, producing dyspnœa in either event.

Internal wounds of the larynx present no objective symptoms to direct inspection. Laryngoscopic exploration reveals the rent or other lesion in some instances, and fails to do so in others. The subjective symptoms are pain, cough, bloody expectoration, dyspnœa or threatening apnœa, dysphonia or aphonia, and dysphagia or aphagia.

Inflammation takes place in all wounds of the larynx or trachea. Sometimes restrained within beneficial limits, it may be excessive in debilitated, starved, or drunken subjects, and may readily become gangrenous.

Diagnosis.—The special diagnostic signs indicating the penetration of an external wound into the air-passages, are the presence of frothy blood at the seat of external injury, escape of air at the same point, or emphysema of the neck from escape of air into the cervical connective tissue, and escape of fluids through the wound on attempts to swallow them. To these may be added aphonia or dysphonia, aphagia or dysphagia, and dyspnœa or threatening apnœa.

Blood which has inundated the air-passage is expectorated in part by the mouth, and in part by the wound. Syncope is the usual result of severe hemorrhage, and in many cases the patients are found in that condition when seen immediately after the injury.

Prognosis.—Although recovery ensues in a large percentage of cases of wounds of the larynx and trachea, the prognosis is almost always to be regarded as doubtful. Wounds apparently insignificant terminate fatally in some instances; and recovery sometimes ensues in very severe cases, even when complicated by multiple section of cartilage, and by extensive injury to the pharynx, œsophagus, and other structures. Horteloup[1] records 67 recoveries out of 88 cases of large wound, and 10 recoveries out of 21 cases of small wound. Recovery is usually more protracted after punctured, lacerated, and gunshot wounds, than after contused and incised wounds.

Contusions of the larynx from blows may, according to Durham, prove suddenly fatal by shock, or by spasm of the glottis. Insensibility is said by the same writer to be a common effect, and one utilized by garroters to rob their victims. Hemorrhagic effusion into the connective tissue may produce suffocation.

Incised wounds of the trachea present a graver prognosis than those of the larynx. In either instance advanced age, insanity, and delirium tremens are additionally bad prognostics. Suicidal wounds, if not fatal within a few hours, may prove slowly fatal by exhaustion or otherwise, in from one to two weeks. Recovery from severe wounds rarely ensues earlier than in four or five weeks, and sometimes occupies a much longer period.

The prognosis is gravest as a rule in gunshot wounds, on account of the complicated nature of the injury in the first instance, which entails inflammatory tumefaction of the superjacent soft tissues, and on account of the greater danger from secondary hemorrhage. Contrariwise to what has been noticed of incised wounds, gunshot wounds of the larynx are much more fatal than those of the trachea. When both of these structures are involved, a fatal result would seem theoretically much more imminent, yet recovery ensued in the four such instances noted in the Medical and Surgical History of the War of the Rebellion. Simultaneous involvement of the pharynx and œsophagus does not seem to add much gravity to the case. Contusions or lacerations of the pneumogastric nerve or of its divisions render the prognosis more unfavorable, on account of the resultant paralysis of the dilator muscles of the glottis, or spasm of its constrictors, with consequent dyspnœa or even apnœa. At a later date, tumefaction of the integument and of the mucous membrane, and extravasations of blood beneath the mucous membrane or in the loose connective tissue, may again threaten death by apnœa.

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[1] Op. cit., p. 86.

In both incised and gunshot wounds, hemorrhage, venous or arterial, may be quickly fatal either by inducing exhaustion or by suffocation. As a rule, however, the bleeding soon ceases with syncope. A small amount of clotted blood in the trachea is sufficient to produce suffocation, if the patient is unable to eject it. Death, immediate or gradual, may ensue, too, from entrance of air into a vein,[1] an instance of which in a case of suicidal incised wound is alluded to by Stromeyer.[2]

After the immediate dangers have subsided, the result of suppuration may derange a favorable prognosis. Escape of mucus, pus, necrosed cartilage, food, or drink, into the air-passages, often occasions septic infection, usually manifested at first in broncho-pneumonia, and in rare instances proceeding to pulmonary gangrene. In this manner a cheerful prospect is often changed into a gloomy one. Circumscribed abscesses may form about the suppurating edges of the wounds, or diffuse ones may dissect the planes of connective tissue down into the mediastina, and thus excite pleuritis, or compression of the bloodvessels and phlebitis. In some instances, too, more especially in gunshot injuries, perichondritis and necrosis of the cartilage takes place, and renders the prognosis still more dubious.

Recovery takes place usually only after protracted treatment, in which weeks upon weeks may be occupied. Gaps in the cartilage become repaired with fibro-cellular tissue, the irregular and exposed edges having meanwhile become necrosed and exfoliated, and the uninjured portions ossified, as is usual in inflammatory affections generally. The tissue filling the gap gradually becomes fibro-cartilaginous, or actually cartilaginous. (Witte, Fischer.) In some instances a permanent fistula of the air-passage remains, often small, but sometimes quite large—after extensive injuries or great loss of substance—huge gaps exposing the epiglottis, the pharynx, and even the pharyngo-palatine folds. Albers, cited by Fischer,[3] describes and illustrates one an inch broad and two inches long. In some instances, either fungous or cicatricial stenosis of the larynx or trachea takes place during recovery, or after it. In the one case, the excessive granulations, or the exuberant tissue, may be destroyed by cauterization, excision, or evulsion. In the other, the permanent use of the tracheotomy-tube is usually required. Attempts to excise or otherwise destroy the obstructive cicatricial tissue are rarely of service; while systematic dilatation is hardly more promising. Recontraction usually takes place on the suspension of the manipulations. A cicatricial membranous web sometimes forms across the larynx at the seat of the wound, a variety of stenosis said to be quite common.[4] Similar stenosis of the trachea is a very rare sequel. (Witte.) Permanent thickening of the cartilages is likewise a frequent result. The dysphonia, or even the aphonia, which accompanies these injuries, is sometimes permanent. Diplophonia, or sudden change of voice from shrill to deep, has been noted by Gibb,[1] after cicatrization of an incised wound of a vocal band.

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[1] Durham, op. cit., vol. i. p. 687.

[2] Op. cit., Bd. ii. S. 310.

[3] Op. cit., Bd. iii. 1 Abth. 3 Lief. S. 96.

[4] Mackenzie, op. cit., p. 409.

Treatment.—The first indication is to avert impending suffocation; the next, to restrain hemorrhage.

Threatening apnœa, as intimated, may be due to nerve-lesions on the one hand—paralysis of the dilators of the glottis or spasm of its constrictors; or on the other hand to mechanical lesions—hemorrhagic or other effusion, œdema, or occlusion by detached portions of tissue. In either instance immediate tracheotomy is demanded, to be followed by the institution of artificial respiration if requisite. This preliminary tracheotomy is much more likely to be necessary in punctured, lacerated, and gunshot wounds, than in simple incised and contused wounds.

Treatment of Contused Wounds.—If respiration be impeded, laryngotomy should be promptly performed through the crico-thyroid membrane, and artificial respiration should be instituted through the opening. Respiration progressing satisfactorily, the next thing is to attend to any symptoms of collapse. This indication is best met by the injection of hot alcoholic fluids into the rectum, and subsequently into the stomach. It may be necessary to resort to hypodermic injections of stimulants, or even to intravenous injections of ammonia.

Treatment of Punctured, Incised, and Gunshot Wounds.—Impeded respiration having been relieved by withdrawal of blood and other liquids from the air-passages—by suction through a catheter, or by tracheotomy—and by removal of clots or detached tissues from occluding positions; hemorrhage having been restrained by ligature or compression; and collapse having been removed by stimulating injections into the rectum, or by hypodermic or intravenous injections, as may be—the next indication is to closely scrutinize the locality of the wound so as to recognize its entire bearings, as far as practicable, before tumefaction renders this impossible.

If the wound penetrate into the mouth, careful search should be made for clots in order to remove them. The tongue should be carefully examined to see whether it be intact. Should it have been severed, the posterior portion should be carefully secured by ligature, so that it may not fall back upon the orifice of the larynx. Any other wounds of the tongue, or any wounds of the palatine folds, should be secured with sutures.

If the wound pass through the hyo-thyroid membrane, or the upper portion of the thyroid cartilage, the condition of the epiglottis should be determined. Any detached pieces should be removed. Attempts at saving semi-severed portions by suture rarely succeed, and almost always entail inflammatory œdema of the epiglottis. If prophylactic tracheotomy have been performed below the injury, attempts to save semi-detached portions of the epiglottis by suture are justifiable; but under other conditions they may be imprudent. In all wounds, whether situated in this region of the air-passage or in any other, search must be made in the wound for any missing portions of cartilage or other tissue, that they may be promptly withdrawn.

If the trachea have been divided, a tracheotomy-tube should be adjusted to the lower segment. If merely punctured, or but slightly severed, the wound should be enlarged, and a tracheotomy tube inserted, unless the opening be so insignificant as to cause neither serious hemorrhage nor emphysema.

Inflammatory or infiltratory tumefaction, or any other sequel which produces sufficient encroachment on the calibre of the air-passage, will demand tracheotomy at any stage of the treatment; a fact recognized and utilized in wounds both of the larynx and of the trachea by Habicot, as early as 1594.[1]

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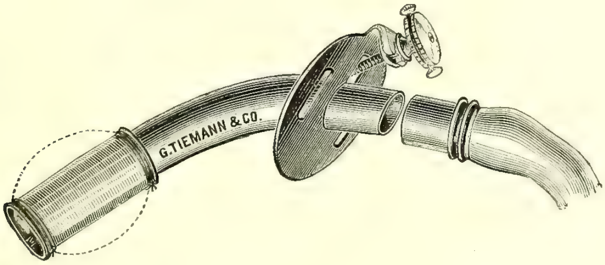
[1] Fischer, op. cit., Bd. iii. 1 Abth. 3 Lief. S. 99.

Severe injuries to the larynx or trachea—whether fracture, laceration, or contusion—and the presence of foreign bodies in the air-tube, demand precautionary tracheotomy to insure the safety of the patient from the dangers of suffocation—dangers which cannot be ignored. The point at which tracheotomy is to be performed will have to be selected with reference to the individual case. This may be just below the cricoid cartilage, further down, or through the crico-thyroid membrane. The tampon-canula (Fig. 1026) is preferable in these cases to the naked instrument, as it occludes the entire calibre of the air-passage. In fact, it is questionable whether all wounds opening into the larynx through the thyro-hyoid membrane, or through the thyroid cartilage, should not be regarded as demanding precautionary tracheotomy. Although it is well known that extensive incised wounds do get well when left almost without surgical interference, it is equally well known that sudden suffocation sometimes takes place, despite every precaution save that of tracheotomy. This subject has been admirably discussed by Witte[2] in an article on wounds of the larynx and their treatment, especially in reference to the value of a prophylactic tracheotomy, the importance of which he has ably demonstrated. The precautionary tracheotomy does not add to the immediate risk in the slightest degree, and suppresses the risk in approximating the edges of the external wound, which is always run under other plans of treatment. Von Langenbeck[3] counsels the performance of tracheotomy in all cases in which either phonation or respiration is seriously impeded.

Fig. 1026.



Trendelenburg's rubber-tampon canula; Gerster's modification. The dotted lines indicate the distension of the soft-rubber jacket when filled with air.

The arrest of primary hemorrhage by syncope is apt to mislead the uncautioned practitioner, and tempt him to close the wound by suture—a procedure which prevents the escape of the blood at the second hemorrhage, which is almost certain to occur when reaction takes place. If the external wound be closed, this blood will run down the air-passage, and may drown the patient, or, clotting, may suffocate him. Cases made fatal by too assiduous attention of this kind are on record, and others are known by tradition and by observation. Liston was one of the most strenuous teachers of the impropriety of such measures, and yet his own house-surgeon would have lost a patient in this way, had his master not instantly cut the sutures and removed a clot which impeded respiration.[1]

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[1] Sur la Bronchotomie. Questions Chirurgicales, chap. xv. pp. 77–83. Paris, 1620.

[2] Arch. f. klin. Chir., Bd. xxi. H. 1, 2, 3.

[3] Militairärtzliche Zeitschrift, Bd. i. S. 60; cited by Witte, loc. cit., S. 395.

It is important, therefore, in treating incised wounds that the parts should not be united by suture until there remains no further risk from reactionary hemorrhage. Arterial hemorrhage must be restrained by ligatures above and below the wound in the vessel, whenever practicable. But even ligature of the bleeding vessel does not secure immunity from the later hemorrhage, for this may be parenchymatous, or may proceed from vessels whose bleeding is not controlled by the ligatures. Should the hemorrhage be profuse, and beyond restraint by compression and by ligature of such vessels as are within reach, the indication would be to tie the carotid artery, a measure successfully employed under these circumstances by Le Gros Clark. When the external wound is very large, it is allowable to unite its outer portions; but the central part should be left open. Should bagging of the horizontal wound take place, the pockets should be divided vertically, as recommended by Stromeyer,[2] so as to prevent the burrowing of pus, which is otherwise almost certain, since union cannot take place by first intention, and extensive suppuration is to be expected. When all danger from hemorrhage has ceased, the tissues on either side of the opening into the air-passage may be brought together with adhesive strips, and a few sutures may be taken into the soft parts, ample room being left for drainage; but no suture should be taken through the cartilage or its perichondrium. Sutures are so illy-borne in these situations, and so pulled on in coughing, that they either cut out and are useless, or excite such an amount of local irritation as to necessitate their withdrawal. Although Prof. Gross and other surgeons express themselves free from fear of this kind, a careful perusal of published records shows that those cases have done best in which these sutures have not been used; and that in most instances in which they have been employed, they have torn their way out, or have had to be removed, even in cases where the wound was not extensive. Sutures are rarely necessary even in the soft parts. They will tear out from the pharynx; while extensive wounds, comprising almost the entire circumference, will, when let alone, sometimes heal up with a very small cicatrix. Should the external wound be drawn together too much, emphysema may take place by interference with the full escape of the expiratory currents of the breath.

The parts having been placed in apposition as far as may be judicious, and the patient placed in the semi-recumbent position, the head is to be flexed and to be retained in position by a cap or handkerchief-bandage (Mayor's occipito-sternal cravat) attached to a chest bandage beneath the arms, or to the waistband of a pair of drawers, or to the foot of the bed—the object being to maintain the horizontal edges of the wounds in juxtaposition, and thus to favor cicatrization, which may be expected in from two to three weeks. The head should not be drawn so far forward as to make the edges of the wound overlap. Prof. Stromeyer attaches a small tuft of hair sidewise over the brow to a bandage fastened to a girdle or jacket, to act as a reminder to the patient to avoid incautious movements. He mentions the case of a man in whom the sterno-mastoid muscle had been cut through; and although the head stood straight when no movement was made, it flapped toward the opposite side on the slightest movement, as quickly as the snap-to of the blade of a pocket knife; an action which ceased as soon as the head was bound by a tuft of hair to the opposite side.

The dressing should be completed by covering the wound lightly with a piece of gauze, or a woven scarf, to raise the temperature of the inspired air and prevent the access of flies. This dressing may be carbolized. The apartment should be kept at a warm temperature, and the atmosphere moist, just as after ordinary tracheotomy. Insane patients and determined suicides require close watching, to see that the dressings remain undisturbed.

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[1] Practical Surgery, 2d ed., p. 364. London, 1838.

[2] Op. cit., S. 32.

The inflammatory action following the injury is to be treated on ordinary antiphlogistic principles, locally and constitutionally; by rest, cold, anodyne fomentations, and leeches, if necessary, and by febrifuge and anodyne mixtures.

If œdema of the larynx or other obstruction to respiration occur at the seat of injury, the trachea should be opened at a lower point, and a tube introduced. A precautionary, prophylactic tracheotomy will have anticipated this contingency.

Emphysema of the neck may require punctures or incisions through the integument; but if the edges of the wound be not yet adherent, the air can often be expelled by systematic manipulation towards the orifice. Should this be unsuccessful, the external wound should be enlarged, and the process repeated. Low tracheotomy is sometimes required under similar conditions to prevent suffocation; and quite a long tube, or a section of rubber tubing, may be necessary for a few days to insure access of air into the trachea. Exuberant granulations should be cauterized with solid nitrate of silver. Cough is to be repressed by anodynes.

Nourishment can be given by the mouth if there be no wound of the pharynx or œsophagus, and can usually be well taken even though the epiglottis have been severed. If those structures have been wounded, it is best to insert a soft rubber catheter through the larger nasal passage into the œsophagus, where it may be maintained undisturbed for several days. Most surgeons prefer that the tube should be inserted through the mouth. Liquid nourishment can be passed through the catheter at stated periods by means of a syphon-tube or funnel, the external orifice being, in the intervals, secured by a ligature. Food may likewise be administered by enema; and medicine, if necessary, by either method, or by hypodermic injection.

Antiseptic sprays allowed to play upon the wound at stated intervals tend to keep the granulations clean and healthy. The secretions escaping from the wound should be caught upon a disinfected sponge or mop as fast as they are expelled, to prevent them from being sucked back by the inspiratory current.

The administration of opium is indicated to restrain hypersecretion and to repress cough, but caution is requisite to avoid obtunding sensibility to such an extent as to favor the passage of fluids into the air-tube.

Should the wound fail to unite in its entire extent, the fistulous opening which remains can sometimes be closed by systematic cauterization, nitric acid and nitrate of mercury being the most efficient agents. In case of failure by this plan, a plastic operation may succeed. Transplantation of cartilage from the ear of the rabbit might be tried under these circumstances.

A pad, secured by a bandage, is sometimes worn over the opening, so that voice and articulation can be rendered effective.

Stenotic constrictions can sometimes be overcome by systematic dilatation. Successes have been reported by Liston and others. In many instances, perhaps in most, a tracheotomy tube becomes a permanent necessity. It is sometimes practicable to overcome the stenosis by dilatation years after immediate treatment has been discontinued. In a case placed under my care by Prof. Joseph Pancoast, of Philadelphia, in 1866, this was satisfactorily accomplished by the frequent passage of large, perforated, hard catheters through the wound, which was just below the vocal bands, up into the mouth, and by see-sawing them forcibly for a few moments at a time.

In a case of extensive adhesion of the vocal bands in a case of cut-throat, Dr. Eysell, of Halle, succeeded in effecting the division with a narrow tenotome passed through the cicatrix.[1]

Treatment of Wounds of Internal Origin.—If respiration be very much impeded, prophylactic tracheotomy is indicated in this class of wounds, as in those of external origin, and for like reasons. Foreign bodies must be removed; whether by the aid of laryngoscopic manipulation, or by gaining direct access externally, will depend upon conditions which will be discussed hereafter. If there be great tendency to hemorrhage, the tampon-canula instead of the naked instrument, should be inserted into the tracheotomy wound. Locally, cold externally, ice-pellets in the mouth, and sedative inhalations in spray, are indicated to repress inflammation and allay pain. Topical applications of solutions of morphia or of aconite are useful when the pain is severe.

II. BURNS AND SCALDS OF THE LARYNX AND TRACHEA.

Burns and scalds of the larynx and trachea are usually associated with similar injuries to the mouth, tongue, palate, nasal passages, pharynx, or œsophagus.

Burns are most frequently produced by the inhalation of flame, hot steam, or the heated air and smoke of burning houses or ships. They are often associated with burns of the head, neck, arms, and chest, and sometimes with burns over large portions of the body. *Scalds* are usually due to the voluntary or involuntary deglutition of hot and caustic fluids. Some scalds from caustic substances in adults are suicidal. Scalds were formerly quite prevalent in England among the children of the poor, who, having been accustomed to drink cold water from the spout of a tea-kettle, endeavored to quench their thirst while the vessel contained boiling water.[2]

When flame or hot air is inhaled, and when hot or caustic fluid is swallowed unknowingly, the larynx is much more likely to be involved than when the drink is taken designedly. In the latter case, the epiglottis protects the larynx as usual from ingress of fluid, and the injury is sustained chiefly in the mouth, pharynx, and œsophagus—sometimes even in the stomach—the act of deglutition having been completed despite any pain or spasm. In unwitting deglutition, however, the epiglottis is surprised, as it were, and fails to occlude the larynx efficiently, so that that organ sustains the brunt of the injury. It is contended, too, that an involuntary inspiration draws the caustic fluid into the larynx. Spasm of the glottis takes place, as a rule, protecting the subglottic portion of the larynx; for the portion below the vocal bands is often found normal in post-mortem examination after these accidents,[3] the injury having been confined to the upper part. Swallowing is rarely completed under the circumstances just indicated, and regurgitation takes place in part through the nasal passages, thus injuring the mucous membrane of that region and of the adjoining retro-nasal portion of the pharynx.

In support of the statement that hot and caustic fluids taken accidentally are rarely swallowed, it may be mentioned that, on consulting the records of numbers of cases in which boiling water has been taken into the mouth, and in which death has ensued from the resulting laryngitis, no evidence has been found of the fluid having reached the stomach in any instance, and in but few cases had it reached even the upper portion of the œsophagus. I have seen no record of deglutition of boiling water for suicidal purposes; but it is fair to infer that a case of the kind would furnish evidence that the fluid had reached the stomach, just as acid and caustic solutions do in suicidal cases.

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[1] Med. Times and Gaz., October 17, 1874; Am. Journ. Med. Sci., January, 1875, p. 275.

[2] Marshall Hall, Med.-Chir. Trans., vol. xii. London, 1822; and others.

[3] For recent examples, see Davies-Colley, Med. Times and Gaz., February 18, 1882.

Acute laryngitis, *laryngitis combustionis*, rapidly supervenes upon burns and scalds of the larynx, often immediately. It is often intense, and is generally attended with extensive œdema. It is not limited to the mucous membrane, but engages the submucous tissues likewise. The inflammatory process is usually confined to the supra-glottic portion of the larynx; but in some instances it extends to the trachea and the bronchi, and even to the lungs. Pneumonia and broncho-pneumonia may supervene without direct implication of the trachea and the larger bronchi. In some instances the inflammation does not overstep the pharyngeal surface of the larynx. In others a plastic, exudatory slough, similar to the plastic exudation of croup—showing arrested circulation from the violence of the inflammation, and consequent necrosis of the mucous membrane, *coagulation necrosis* (Weigert)—is produced along the entire tract of injury and beyond it. It has been found after death in the larynx, trachea, and bronchi.

Symptoms.—The immediate symptoms are pain, dyspnœa, dysphagia, dysphonia or aphonia, shock, accelerated pulse and respiration; and, at a later period, inspiratory stridor, spasm, threatening suffocative apnœa, and collapse. In cases of burns from the heated air and smoke of burning buildings, the sputa may contain black, carbonaceous material.[1] Œdema of the epiglottis or of the aryteno-epiglottic folds may be almost immediate, or may be developed during the course of a few hours. In cases associated with burns of the trunk and limbs, rather than of the head and neck, it may not occur within a week.

The symptoms do not always appear at once. Thus, Porter[2] says that he knew a girl, after swallowing a dose of sulphuric acid, to sit quietly and drink tea with some companions, who were afterwards suspected of having poisoned her, although the dose had been so powerful that she died in a few hours. He likewise knew of a man who took a second drink of the sulphuric acid, because he thought that the first dose was not sufficiently quick in dispatching him.

Diagnosis.—Except when the nature of the accident is purposely concealed by a determined suicide, the diagnosis is easy, especially in adults. Severe pain in the part, dyspnœa, dysphagia or aphagia, acceleration of the pulse and respiration, and the history of the case, are usually sufficient to establish the fact of a burn or scald. The interior of the mouth, the posterior portion of the tongue, the palate and pharynx, if seen early, are inflamed, swollen, and vesicated or blistered, or are covered with white patches, as though cauterized—often from detachment of a slough of epithelium—while the mucous membrane is seen to have undergone destruction in spots. In some instances, the œdematous epiglottis can be seen erect on ordinary inspection.[3]

There are few records of laryngoscopic examination of the parts injured. Tuerck[4] has depicted the laryngoscopic appearance of a circumscribed, symmetrical cauterization of the outer, inferior surfaces of the arytenoid cartilages, from deglutition of dilute nitric acid. In a case examined by myself,[1] there was œdema of the aryteno-epiglottic folds, in a case of burn of the larynx, the result of inhalation of flame in a burning building.

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[1] Cohen, Inhalation: its Therapeutics and Practice, p. 294. Philadelphia, 1869.

[2] On the Larynx and Trachea, p. 178. London, 1837.

[3] Mackenzie, op. cit., p. 281.

[4] Klinik der Krankheiten des Kehlkopfes und der Luftröhre, S. 182. Wien, 1866.

Prognosis.—The prognosis is always grave when the injury has been extensive, recovery being rare in severe cases. In slight cases the patients may recover thoroughly in a few days, but in severe cases they may perish at once, or within from twenty-four to forty-eight hours. The suppuration is profuse and exhausting. Sloughing of the arytenoid cartilages has been observed. (Ryland.) When recovery does ensue, it is often with permanent stenosis of the larynx, cicatricial and infiltratory, requiring the use of the canula for respiration through an artificial opening.

Death may take place by shock or by suffocative apnœa, or at a remoter period by laryngitis, bronchitis, or pneumonia. Even though immediate death by threatening suffocation be averted by tracheotomy,[2] statistics show that more than half of the patients operated upon perish.

Treatment.—It is very rarely that a patient is seen soon enough after swallowing an acid or caustic alkali, to expect advantage from administering neutralizing agents, whether by deglutition or by the stomach tube. In severe cases of burn or scald of the larynx, precautionary tracheotomy seems to be demanded, as the laryngitis excited is apt to be attended with œdema of the larynx, which may prove fatal by suffocation before surgical relief can be given. Most surgeons, however, prefer to await the onset of the threatening symptoms, this delay, perhaps, accounting in part for the slight amount of success which follows tracheotomy in these cases. Durham[3] reports that of 28 cases of tracheotomy in scald of the larynx, of which he had notes, 23 terminated fatally. If tracheotomy be deemed unnecessary, puncture or scarification of the œdematous mucous membrane may be employed with great advantage, and in some instances may obviate the necessity for the graver operation.

As the inflammatory process rarely extends below the glottis, owing to spasmodic closure of the vocal bands at the time of the injury, the larynx may be opened through the crico-thyroid membrane in these cases; especially in the adult, in whom the opening will be large enough to admit a sufficiently capacious tube. The operation is much less successful in children than in adults; the hemorrhage being more profuse, and the debility greater from the loss of blood.

Slight cases may be treated efficiently by rest in the recumbent position, cold compresses or ice externally, and anodyne inhalations in vapor or in spray. Mucilaginous drinks are soothing to the parts, and contribute somewhat to nourishment. Anodynes may be combined with them. Sprays of acetate of lead and of carbonate of sodium sometimes afford great relief.

Severe cases require active antiphlogistic treatment, locally and constitutionally. Collapse having been counteracted in the first instance by stimulant enemata, blood may be drawn by leeches from the upper portion of the sternum, and the same part may then be covered with warm, sedative fomentations, while ice-bags, iced-water tubes, or cold compresses may be applied over the larynx as in milder cases. If the patient can swallow, an emetic should be given by the mouth; if not, emesis may be excited by apomorphia hypodermically. Mild chloride of mercury in doses of one, two, or three grains, every half hour, hour, or two hours, until free bilious evacuations ensue, has been highly recommended.[1] Mercurial inunction may be substituted, if swallowing be impracticable, and may hasten the specific action of the drug when calomel is given internally. Durham[2] reports the best results in burns from the administration of preparations of antimony and aconite, in small doses frequently repeated; the intervals being but fifteen minutes for the first hour or so, and being then lengthened according to the effects produced. Anodynes may be given by the mouth or hypodermically, as indicated. Pellets of ice in the mouth, *ad libitum*, add much to the comfort of the patient, and tend to repress inflammation. Milk may be given as nourishment in most instances. If dysphagia prevent deglutition, the rectum must be depended on for the introduction of nourishment.

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[1] Inhalation, its Therapeutics and Practice, p. 294. Philadelphia, 1867.

[2] Kuehn, Die künstliche Eröffnung der Luftwege, S. 278. 1864; Gurlt, Arch. f. klin. Chir., Bd. i., S. 172, 194; Bryant, Surgical Diseases of Children, p. 67. London, 1863; Durham, op. cit., vol. i. p. 701.

[3] Op. cit., vol. i. p. 701.

Œdema of the Larynx.

Œdema of the larynx, long incorrectly called œdema of the glottis, for the rima glottidis is rarely involved, is an infiltration of fluid or semi-fluid products into the submucous connective tissue of the upper or of the inner surface of the larynx, or of either surface of the epiglottis. It is rarely an œdema in the strict sense of the word—a hydrops, that is to say, or a passive accumulation of serum—but it is rather an œdematous infiltration accompanying an inflammatory process by which it has been occasioned, whatever may have been the origin of the inflammation. Thus, the infiltration may be serous, lymphous, sero-sanguinolent, sanguinolent, sero-purulent, or purulent. The serous effusion occurs in cases marked by great rapidity of morbid action, and the purulent in cases of slower and less violent inflammation. Hemorrhagic effusions are sometimes instantaneous, as in contused and other wounds. Lymphous effusions are usually gradual. The œdema may be acute or may be chronic. Sometimes the process is idiopathic, sometimes traumatic, and often deuteropathic. However occasioned, the effusion diminishes the space for breathing, so that the process of respiration becomes first impeded and then obstructed; and if subsidence of the effusion does not take place spontaneously, or by prompt surgical interference, rapid apnœa by suffocation may ensue, or slow apnœa by congestion of the brain or lungs, death taking place within a few hours or a few days as may be.

The pathology of acute œdema of the larynx was not understood before the present century; and many cases, among them, most probably, the fatal cases of General Washington and of the Empress Josephine, were looked upon as cases of croup, the subjective symptoms of which are closely similar. But in 1808, a remarkable paper by Bayle[3] was presented to the Society of the Parisian School of Medicine, fully discriminating the malady from all others, and this led the way to its thorough recognition, and to its prompt and intelligent treatment. Impediment to free circulation in the venules of the laryngeal mucous membrane, whether from inflammatory process, mechanical obstruction, or paralysis of vessels, is the immediate physical cause of the effusion as in the case of many other serous accumulations—the remoter cause being idiopathic or deuteropathic inflammation, or mechanical or surgical injury.

Mechanical impediment to respiration by the tumefaction of the tissues hardly represents the entire pathology of the dyspnœa in laryngeal œdema.

[1] Wallace, Lancet, 1833, vol. i. p. 657; Bevan, Dub. Quart. Journ. of Med. Science, Feb. 1860; Sloane, Brit. Med. Journ., Jan. 14, 1866; Croly, ibid., June 16, 1866; and others.

[2] Op. cit., vol. i. p. 700.

[3] Mémoire sur l'œdème de la glotte ou angine laryngée œdémateuse.

Spasm of the muscles closing the glottis (lateral crico-arytenoids and central arytenoid), or paralysis of the muscles opening it (posterior crico-arytenoids), probably exists in many instances. Otherwise it is impossible to account for the fatal issue, even allowing that the œdema subsides after death. As elsewhere mentioned,[1] the encroachment upon the breathing space has been seen laryngoscopically to be much less in some instances than would be credited without inspection, although the swollen tissues cast such shadows upon the glottis as to render it impossible to pronounce as to its patency. These views have received additional support from recent observations[2] of actual obstruction of the glottis by paralysis or spasm.

ACUTE ŒDEMA OF THE LARYNX from acute laryngitis usually occupies the two aryteno-epiglottic folds, although instances occur in which but one is involved. The epiglottis may be involved likewise, or it may be the sole location of the effusion. The ventricular bands, the inter-arytenoid folds and the inner aspect of the arytenoid cartilage, are much less frequent seats of the process; and the vocal bands, with their intrinsic thyro-arytenoid muscles, are the least frequent seat. Occasionally the process is wholly subglottic. Œdema of the tracheal submucous tissue occasionally occurs, six instances of this condition having been collated by Sestier[3] out of a total of one hundred and thirty two of œdema of the larynx. Infiltration into the base of the tongue and into the pharynx is a more frequent complication.

CHRONIC ŒDEMA OF THE LARYNX occurs as an epiphenomenon in the chronic laryngitis of tuberculosis and syphilis, both ulcerative and non-ulcerative; in laryngeal perichondritis and chondritis of whatever origin; in the irritative laryngitis due to morbid growths; in carcinoma of the larynx or pharynx; in glossitis; in the pharyngitis consecutive to tonsillitis and to malignant disease of the tongue, palate, pharynx, and œsophagus, whether implicating the larynx directly or not; in glandular and other cervical and mediastinal tumors; in thoracic and abdominal aortic aneurisms; and in fractures, wounds, and other injuries of the larynx, adjacent soft tissues, or great cervical bloodvessels. Under these circumstances the affection becomes for the time more important than the disease which has occasioned it.

It comes on gradually, rarely without prodromic manifestations, and may continue for weeks and months before it excites a suffocative paroxysm, even though it present great occlusion of the orifice of the larynx. This occlusion occurs so gradually that the system becomes accustomed to it; for the same amount of œdema in an acute case would be almost certain to produce intense dyspnœa, suffocative paroxysms, and passive pulmonary congestion.

Chronic œdema is more frequently unilateral than acute œdema, the diseases of the larynx which produce it being themselves often unilateral.

SUBGLOTTIC ŒDEMA OF THE LARYNX is not frequent. The closeness with which the mucous membrane hugs the perichondrium below the vocal bands does not favor accumulations of fluid in that region. Still, there is some loose connective tissue in the lateral regions of the cricoid cartilage, where such accumulations can take place. The effusion is usually fibrinous; rarely serous. It is usually independent of any effusion in the upper portions of the larynx; but the two conditions have been known to coexist.[4]

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[1] Diseases of the Throat, etc., 2d ed., p. 443. New York, 1879.

[2] Gougenheim: Annales des Maladies du Larynx, etc., Juillet, 1883, p. 125.

[3] Traité de l'angine laryngée œdèmateuse. Paris, 1852.

[4] See Specimen in St. George's Hospital Museum, London, described by Gibb (op. cit., p. 218).

Etiology.—Very rarely, indeed, is acute œdema of the larynx a primary, idiopathic affection. Sestier[1] noted 36 cases out of 190. It has been known, however, to follow so closely upon exposure to cold and rain, deglutition of very cold drinks,[2] and prolonged vocal effort, as to seem primary; but acute or subacute inflammatory laryngitis may have preceded. It may follow traumatism quite as promptly, for Ziemssen[3] has reported a case, in a man who was smoking, of death within a few minutes after penetration of the wall of the laryngeal ventricle by a piece of rib of tobacco-leaf. It often occurs in the traumatic laryngitis from deglutition of hot and caustic solutions, from burns, or from the presence of foreign bodies. It is quite frequent in wounds of the larynx. It may occur in gunshot wounds of the neck, even when the larynx is not implicated. Thus, fatal œdema is reported on the fourth day after such a wound from a 1¼ inch grape-shot, which entered near the right horn of the hyoid bone, passed obliquely across the neck, and lodged in the subscapular fossa, whence it was removed by incision.[4] It sometimes occurs in sore throat. Roger[5] relates an instance of sudden death in a slight case of sore throat in a hospital servant. Trousseau mentions a case saved by tracheotomy, in which it occurred from sleeping in the open air after an evening's debauch;[6] and Laverau, a case fatal within fifteen minutes, in a soldier, a day after suspension of treatment for sore throat.[7] Simple inflammation was regarded as the cause in more than six per cent. of Sestier's cases. In such instances, Mackenzie[8] believes the œdema to be nearly always due to blood-poisoning.

Œdema of the larynx has been noted in aneurism,[9] obstruction of the hepatic duct,[10] erysipelas,[11] ecthyma,[12] scarlatina,[13] measles,[14] smallpox, facial erysipelas (by myself), typhus and enteric fever,[15] glanders, nephritis,[16] whooping cough,[17] capillary bronchitis, pneumonia, croup, diphtheria, and marasmus.[18] It is chiefly in the waning stages of these affections, or during convalescence therefrom, that the œdema takes place, probably in consequence of lack of protection from drafts of air. It is a rare accompaniment of general anasarca, probably because there is no sore throat or laryngitis to start it.[19] It occurs occasionally in acute iodism[20] and in mercurialization. It is therefore prudent to supervise patients with laryngeal disease to whom, for the first time, mercury and iodine are being administered in decided doses. Phlegmonous glossitis, and diffuse inflammation of the connective tissue of the neck, sometimes give rise to œdema of the larynx, by contiguity.

Mackenzie[21] attributes œdema of the larynx largely to septicæmia, having met with the affection in hospital physicians, medical students, and nurses, and in cases where defective drainage seemed to be its cause. He adds that in every case that has come under his notice, ample opportunity of acquiring septicæmia has been present. Exposure to cold and moisture appears to be the usual exciting cause, in idiopathic and deuteropathic œdema, whatever the predisposing cause. Acute œdema from disease is exceedingly infrequent in childhood. Out of a total of 245 cases, Sestier[1] reports five under five years of age, one being in a new-born infant, and twelve cases between five and fifteen years. It is much more frequent in men than in women; simply, probably, because of their greater exposure to atmospheric changes. Of 187 cases in adults, in Sestier's lists, but 56 occurred in women. It is more frequent in intemperate individuals than in the temperate. Predisposition seems to exist in some individuals, for cases of recurrence have been recorded.[2]

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[1] Op. cit.

[2] Albers, cited in my work already quoted (Diseases of the Throat, etc., p. 477).

[3] Cyclopædia of Practical Medicine, vol. vii. p. 794.

[4] Med. and Surg. History of the Rebellion, Part First, Surgical Volume, p. 404.

[5] Dict. de Méd., t. xxii. p. 575.

[6] Clin. Méd., t. i. p. 651. Paris, 1877.

[7] Gaz. des Hôp., 20 Juin, 1876, p. 565.

[8] Op. cit., p. 274.

[9] Moore, Dub. Quar. Jour. Med. Science, August, 1869, p. 13.

[10] Farre, Lancet, April 21, 1860, p. 393.

[11] Gibb, Diseases of the Throat, p. 218. London, 1864.

[12] Boeckel, Annales des maladies de l'oreille, du larynx, etc., tome i. p. 387.

[13] Barry, Central-Zeitung für Kinderheilkunde, No. 19. 1879.

[14] Ryland, op. cit., Case IV.; Pilcher, An Epidemic of Measles, p. 5. 1876.

[15] Emmet, Amer. Jour. Med. Sciences, July, 1856; Merklein, La France Méd., No. 69, 1883.

[16] Fauvel, Aphonie Albuminurique. Rouen, 1863. (He has shown it to be sometimes the first symptom.); Thompson, St. George's Hosp. Rep., vol. iii. p. 302. 1868; Hayden, Brit. Med. Jour., April 11, 1874, p. 489; myself, and others.

[17] Barthez, Gaz. des Hôp., No. 32, 18 Mars, 1869, p. 121.

[18] Billard, Traité des maladies des enfans nouveau-nés à la mamelle, p. 491. Paris, 1828.

[19] Sestier, Mackenzie.

[20] Nélaton, Abeille Méd., t. x. p. 217; Laurie, cited by Stillé (Therapeutics, 3d ed., vol. ii. p. 763); Fenwick, Lancet, Nov. 13, 1875, p. 698; Cohen, Diseases of the Throat, etc., p. 446, note.

[21] Op. cit., p. 274.

Œdema occurs traumatically from severe intra-laryngeal or perilaryngeal cauterization, and from attempts at removing morbid growths—the epiglottis and aryteno-epiglottic fold, or a supra-arytenoid cartilage, being seized and contused between the blades of forceps.

Symptoms.—Acute œdema of the larynx occurs so suddenly at times that the subject perishes without any premonitory symptoms whatever. Van Swieten[3] mentions a death with sudden change of voice, while dining. Morgagni[4] mentions a similar case, in a physician, who suddenly became hoarse, and died at once. Porter[5] knew of two young men found dead from œdema in the morning, without any complaint having been made by them the night previous. Ruehle[6] mentions a young man with swollen tonsils and overheated by dancing, found dead in the morning from œdema which had suffocated him without awakening him; and likewise the case of a servant girl, slightly hoarse, who went out lightly clad in the morning, and was suffocated while going up stairs on her return.

Sometimes the manifestations are so sudden and intractable that even in a hospital the patient perishes before aid can reach him. Roger,[7] while an *interne* at Hôtel-Dieu, was summoned to an attendant in an adjoining ward, who died of sudden suffocation before he could be reached; and yet there had been no complaint save of a sore throat, so slight as not to interrupt the man's work in the hospital.

These instances of sudden death certainly seem to indicate a sudden occlusion of the glottis from spasm of its constrictors, or from paralysis of its dilators, rather than a mechanical death from serous effusion. It is quite probable that the œdematous condition may have existed for some hours or days undetected and unsuspected, and that some sudden inspiration of dust, or of saliva, has produced an immediately fatal spasm.

Deuteropathic œdema of the larynx may be preceded by pyrexia. In some instances discomfort in the larynx, and a disposition to cough, may exist for two or three days. Much more frequently the symptoms are sudden, marked, and rapidly progressive in severity. They are local tenderness—sometimes amounting to intense pain in acute cases—with hot and dry throat, and a sense of constriction or obstruction within it. Inspiratory stridor now ensues, sometimes sonorous or sibilant, and this rapidly increases until suffocative apnœa seems impending. Cough occurs in the form of voluntary efforts to rid the throat of the obstruction within; and saliva and mucus are sometimes expectorated. The voice gets feeble, then indistinct, and finally extinct in some instances. Dysphagia exists in consequence of the swollen epiglottis or margin of the larynx, and sometimes amounts to aphagia. Forced deglutition has sometimes proved immediately fatal. Restlessness soon ensues. Sleep may be impossible from fear of suffocation, or occasional slumbers are soon broken by suffocative paroxysms. These often subside quickly at first, leaving intervals of absolutely unimpeded respiration—further evidence in favor of the nervous origin of the dyspnœa and the stridor. The obstruction to breathing is at first confined to the inspiratory phase of the act, and is generally attributed to occlusion of the entrance of the larynx, by contact of the tumid folds of tissue approximated by the force of the atmospheric current upon them. This turning in of the upper portion of a pair of œdematous aryteno-epiglottic folds can be recognized laryngoscopically, and occasionally directly, in cases of incised wound through the hyo-thyroid membrane, even though the inferior portions of the swollen tissues are drawn apart by the separation of the arytenoid cartilages in the inspiratory act. After a while breathing becomes obstructed in the expiratory phase of the process also. The usual physical phenomena of suffocation are recognized: general agitation; anxious countenance; face flushed at first, and then livid; lips and tongue blue; eyeballs projecting; respiration shallow, hurried, and perhaps spasmodic or gasping; pulse small, quick, and frequent. Death may ensue in the first paroxysm, or in any subsequent one.

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[1] Op. cit.

[2] See particularly case of Roberts, *infra.*

[3] Cited by Ruehle, Die Kehlkopf-Krankheiten, S. 158. Berlin, 1861.

[4] De Sed. et Caus. Morborum, Epist. xxii.; cited by Bayle.

[5] Surgical Pathology of Larynx and Trachea, p. 82. London, 1837.

[6] Cited in my work already quoted, p. 447.

[7] Dict. de Méd., t. xvii. p. 575.

In acute œdema the paroxysms are usually abrupt, violent, and irregularly recurrent at intervals of a few hours. Slight agitation or emotion may bring them on.

In chronic œdema they usually follow steadily increasing dyspnœa, culminating in a paroxysm which is followed by relief to the difficulty of breathing, and does not recur for a few days, or even for a few weeks. The intervals gradually diminish, until finally several paroxysms a day may occur, those at night being the most severe.

The subjective symptoms of subglottic œdema of the larynx are similar to those of acute laryngitis, with the addition of mild symptoms of ordinary œdema of the larynx; but the stridulent dyspnœa is present in both phases of respiration, and is attended with a noisier hoarseness. There is more cough, and more expectoration of mucus, rings of fibrinous sputa being sometimes ejected. Dysphagia does not occur unless there be œdema of the upper aperture of the larynx also.

Diagnosis.—The tongue, palate, uvula, tonsils, and even the pharynx, sometimes show evidence of infiltration—usually when the œdema is the result of acute inflammation; but in many instances there is no manifestation of disease in these structures. In some cases the œdematous epiglottis is visible without depression of the tongue; in others it is brought into view by that manipulation. If the tongue be so far depressed as to induce retching, the swollen aryteno-epiglottic folds will sometimes come into view.

The marked inspiratory dyspnœa, with comparative freedom in the expiratory phase of breathing, is to be regarded as a characteristic symptom, though by no means pathognomonic. According to Billard,[1] œdema of the larynx in the new-born is indicated by a peculiar, bleating cry, veiled and incomplete. Digital exploration will readily detect œdema of the epiglottis or of the aryteno-epiglottic folds; but the manipulation has been known to produce serious suffocative phenomena.[2] Forward and upward manipulation of the larynx, externally, affords no relief to the dyspnœa as it does in retropharyngeal abscess, and serves therefore as a method of discrimination.

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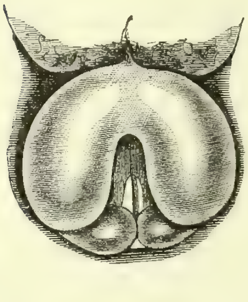
[1] Op. cit., p. 489.

[2] Trousseau, Clin. Med., New Syd. Society's transl., vol. iii. p. 98.

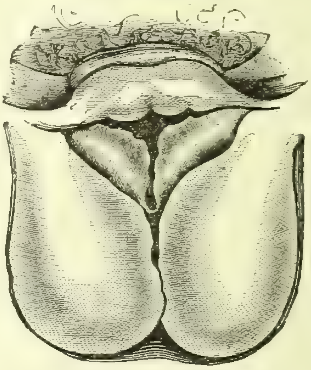
Accuracy in diagnosis is assured at once by laryngoscopic inspection. The œdematous epiglottis presents itself as a gelatinoid, quivering tumor, varying in size from that of a peanut to that of a walnut. Its configuration varies. Occasionally it is constricted by the glosso-epiglottic ligament, so as to resemble two bladder-like projections instead of one. Sometimes it looks like a large, limpid sac overhanging the upper aperture of the larynx. The laryngeal surface does not favor accumulations of fluid; hence the œdema is usually confined to the lingual surface and the crest.

Fig. 1027.



Œdema of epiglottis.

Fig. 1028.



Œdema of aryteno-epiglottic folds.

Œdema of the aryteno-epiglottic fold, usually bilateral, appears, in the laryngoscopic image, as a pale pink or yellow, translucent or semi-translucent, pyramidal tumor, resembling in color an œdematous prepuce or an œdematous eyelid. As a rule, the ventricular band (false vocal cord) becomes obliterated into a mass continuous with the aryteno-epiglottic fold. When bilateral, the œdema is usually unequal. Sometimes these tumors are livid. They may attain the size of a pigeon's egg. The swollen folds of tissue project towards each other, and occlude the calibre of the upper portion of the larynx—the glottis of the ancients—hence, probably the term *œdema glottidis.* The space between them becomes diminished to a mere slit; and in pronounced cases, this slit becomes smaller during inspiration, from the pressure of the inspiratory current, which slightly forces its surfaces into contact. Sometimes, indeed, they stick together for a moment. During the expiratory phase of respiration they separate, at times sufficiently to disclose the vocal bands beneath them. Gougenheim[1] denies this downward and inward movement by atmospheric pressure, and asserts that the œdematous folds separate in inspiration, following the movements of the vocal bands. He attributes the dyspnœa to spasm. That he is correct as far as concerns the cases observed by himself, there is no reason to doubt; but I have noticed the action above described, not only laryngoscopically, but likewise directly, in the œdema consecutive to suicidal wounds of the neck which exposed the larynx to direct view.

In a case of acute inflammatory œdema of the vocal bands recorded by Semon, " the upper surfaces of these structures were quite rounded, so that they looked semi-cylindrical," and " their color was changed into a bright, semi-transparent red."

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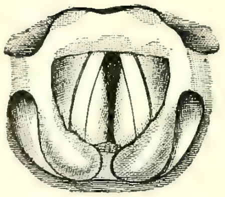
[1] Annales des Maladies de l'Oreille et du Larynx, etc., p. 125, Juillet, 1883.

In subglottic œdema of the larynx, laryngoscopic inspection reveals projecting tumors beneath the vocal bands. (Fig. 1029.)

Fig. 1029.



Subglottic œdema of the larynx.

The affections from which œdema of the larynx is to be discriminated are thymic asthma, stridulous laryngitis, croup, the presence of a foreign body in the air-passage, that of a tumor in the larynx, and compression of the air-passage by an aneurism of the aorta or of the innominate artery. The history of the attack, and inspection with the laryngoscope, will usually suffice for diagnosis. In antelaryngoscopic days, the symptoms due to compression from aneurism were sometimes attributed to œdema of the larynx (Cruveilhier), and tracheotomy even was performed in consequence. (Lawrence, Cheyne.)

Prognosis.—The danger of suffocation, which may come on with little warning, or with none at all, renders the prognosis grave whenever the œdema is extensive or bilateral, or attended with spasm of the glottis. Suffocation has been known to occur at the apparent onset of the œdema, before it has been possible to know what was the matter. Left to itself, a serious case of œdema will be apt to terminate fatally in from three to five days, sometimes by suffocative apnœa, sometimes by slow apnœa, sometimes by supercarbonization of the blood, even after the respiration has become comparatively tranquil.

Idiopathic, serous œdema, in robust subjects, affords a favorable prognosis, provided that prompt measures are taken for relief. Sero-purulent and purulent œdema offer a far less favorable prognosis. That of the œdema attending aneurisms, malignant tumors, and tuberculosis, is always unfavorable. The prognosis is doubtful in the deuteropathic œdema of acute constitutional disorders, such as enteric fever, smallpox, scarlatina, and erysipelas. Both immediate and ultimate prognosis are less favorable in subglottic than in supraglottic œdema.

The prognosis of chronic œdema of the larynx is not so immediately serious as that of acute œdema, but the hope of ultimate recovery is much slighter; and tracheotomy may be indicated for the permanent establishment of an artificial opening for respiration.

Treatment.—The best treatment for œdema of the larynx is to make a few punctures or incisions into the tumid mass, with a well-curved knife protected to within a line or two of its point, so as to give vent to the fluid. Special knives have been constructed for the purpose, which are easier to manipulate, but in an emergency a gum-lancet will be found quite efficient. If practicable, the little operation should be performed under guidance of laryngoscopy; otherwise the forefinger of the disengaged hand may be relied upon as the guide for the knife. It is not necessary to make an intra-laryngeal cut for œdema of the aryteno-epiglottic fold. An incision in the exterior wall will do just as well, and will avoid the entrance of blood into the air-passage. A little spasm follows the cut, and seems to help force the serum out. The hemorrhage is insignificant in most instances, amounting usually to less than a drachm, and rarely to more than two or three; but occasionally the bleeding may be profuse, and may require persistent coughing to expel it.[1] Bleeding is more apt to be profuse from scarification of the epiglottis than from scarification of the aryteno-epiglottic fold. When the hemorrhage is slight, it may be encouraged by warm-water gargling, or by inhalations of steam. If the first scarification be effective, a second is rarely required in acute œdema. In chronic œdema, repetitions may be called for from time to time.

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[1] Cohen, op. cit., p. 451.

When the effused products are semi-solid, they cannot be evacuated by scarification. Should the hemorrhage from the operation fail to give relief under such conditions, tracheotomy is indicated. Its postponement surrenders the patient to the risk of suffocation.[1] Too long a delay in tracheotomy may favor death by congestion of the lungs or brain, even though free respiration be re-established[2] for a few hours or a few days. Tracheotomy is preferable to laryngotomy, inasmuch as this sort of laryngeal œdema may extend down to the point of election for laryngotomy, and that operation may, therefore, fail to afford relief. Respiration having been secured by the tracheotomy, ample time will be afforded for deliberate scarification of the œdematous tissues—a proceeding which will be required should deglutition be impeded by the swelling. It is sometimes practicable, as suggested by Stromeyer, to rupture the swollen mucous membrane by strong pressure with the finger at the moment of digital exploration. In one instance of œdema of the epiglottis, I was enabled to perform this little operation with success.

Pressure and scarification failing to afford relief, tracheotomy is indicated at once, lest suffocation ensue before absorption can be induced by constitutional measures. Cases recover sometimes under antiphlogistic treatment,[3] and spontaneous subsidence occurs occasionally, too, within a few hours without treatment; but it is better by far, as regards the safety of the entire number of patients, to perform tracheotomy than to run any risk. Indeed, tracheotomy once indicated in a case not under continuous professional supervision, had better be performed as a precautionary measure even though the urgent symptoms have subsided. Otherwise death may ensue in a fresh suffocative attack.[4]

Frequent compression of the parts to promote absorption (Thuillier), seems hardly worthy of commendation. Catheterization of the larynx usually fails to afford any relief, though Chiari claims good results from this procedure in the acute œdema attending nephritis and inflammation in the vicinity of the larynx.[5]

In cases of moderate severity, unattended with laryngeal spasm, iced applications externally, and ice in the mouth, will sometimes favor absorption of the effused serum, and obviate any necessity for resort to the knife.

In *hemorrhagic œdema*, puncture or incision of the mucous membrane is indicated to give vent to the effused blood. Pellets of ice in the mouth, and the administration internally of turpentine or ergot, or the hypodermic administration of the latter, are likewise indicated. Should suffocative apnœa be threatened, tracheotomy becomes indicated for the reasons already alluded to.

In *sub-glottic œdema*, scarification is the theoretic remedy; but the location of the lesion renders it impracticable to follow the indication. In mild cases, the constitutional influence of mercurials may be tried in the first instance. Tracheotomy once indicated, should not be long deferred, lest, as in an unfortunate instance in my early practice, it may fail to save the patient from the lethal effects of prolonged supercarbonization of the blood.

In some cases of this kind it becomes impossible to dispense with the tracheotomy tube, the effused matters failing utterly to undergo absorption under any treatment.

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[1] For a recent case in point, see Jour. de Méd. de Bordeaux, 24 Juin, 1883.

[2] Pitman and Page, Lancet, April 21, 1860, p. 392.

[3] Wilson, Med. Chir. Trans., vol. v. p. 156; Arnold, ibid., vol. ix. p. 31; Anderson, Edinb. Med. and Surg. Jour., vol. x. p. 284; Roberts, Med.-Chir. Trans., vol. vi. p. 135. Roberts's patient died in a subsequent attack fourteen years afterward.

[4] Jour. de Méd. de Bordeaux, 24 Juin, 1883; Med. and Surg. Reporter, Sept. 8, 1883. p. 276.

[5] Monatsschrift für Ohrenheilkunde, Juni, 1881; Rev. mens. de Lar., etc., Janv. 1882, p. 25.

In *chronic œdema*, tracheotomy can do little more, in many cases, than put the larynx at rest for a time. In many instances it but adds additional irritation to the evils already in existence. It does not facilitate the cure of the affection. In case of threatening suffocation, it is demanded as in similar conditions under other circumstances.

Scarification, followed by topical applications of strong astringents, such as solutions of nitrate of silver, chloride of gold, chloride of zinc, and sulphate of copper, sometimes reduces the tumefaction for a time. Sedative inhalations relieve the local distress. Blisters and other counter-irritants are rarely efficacious, and are sometimes injurious. These cases, as a rule, are hopeless.

FRACTURES OF THE LARYNX AND TRACHEA.

FRACTURE OF THE LARYNX.—Fractures of the larynx are not frequent. They are commonly the result of great violence. They are usually associated with a wound of the integument, but the reverse occasionally occurs.[1] Sometimes they are associated with fractures of the hyoid bone, and occasionally with fractures of the lower jaw and of the extremities.[2] There may be a single fracture, or several fractures. Multiple fracture of the cricoid cartilage is rare.[3] Ossification of the cartilages is assigned as the chief cause of multiple fracture. The fracture may be complete or incomplete. It may be simple, compound, complicated, or comminuted.

But little was known of fracture of the larynx before the eighteenth century. The earliest record is usually attributed to Morgagni,[4] and among the earlier cases may be mentioned those of Valsalva (1703), Weiss (1745), Colombo, and Plink (1775).[5]

The subject has been particularly studied or discussed by Malgaigne,[6] by Cavasse,[7] by Gurlt,[8] by Hunt,[9] by Fredet,[10] by Hénoque[11]—who sums up the conclusions of the writers referred to, and others with them—and by Caterinopoulos.[12]

Usually the fracture is limited to the thyroid and cricoid cartilages. I know of no positive record of fracture of an arytenoid cartilage, save an undefined "articular fracture" of the right arytenoid in a case cited by Cavasse. The arytenoid cartilages, moving so freely on the cricoid, are much more apt to suffer luxation. In extensive injuries, indeed, such a luxation is not infrequent, and is often a serious element of danger. In many cases both the thyroid and the cricoid cartilages are fractured. The thyroid suffers much more frequently than the cricoid when but one cartilage is broken. In 52 cases collected by Hénoque, the thyroid alone was fractured in 23, the cricoid alone in 7, and both cartilages in 7. Durham[13] adds seventeen cases, four of which are personal, to the fifty-two collected by Hénoque, with the following summary: indefinite "fractures of larynx" 7; thyroid only 30; cricoid only 11; thyroid and cricoid 9; thyroid, cricoid, and trachea 2; cricoid and trachea 3; thyroid and hyoid bone 4; thyroid, cricoid, and hyoid bone 2; cricoid, trachea, and hyoid bone, 1.

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[1] Macler, Union Méd., 1864, p. 142.

[2] Bell, Lancet, Oct. 21, 1871, p. 571.

[3] Treulich's case, *infra*.

[4] Op. cit., epist. xxix.

[5] Masucci, Arch. Ital. di Lar., Anno i., 1881–2, p. 110.

[6] Traité des fractures et des luxations, tome i. Paris, 1847.

[7] Essai sur les fractures traumatiques des cartilages du larynx. Thèse de Paris, 1850.

[8] Handbuch der Lehre von den Knochenbrüchen, Theil. II; Lief. i. Hamm, 1864.

[9] Am. Jour. Med. Sciences, April, 1866, p. 378.

[10] Gaz. des Hôp., 1868, Nos. 90, 91; Quelques considérations sur les fractures traumatiques du larynx. Paris, 1868.

[11] Gaz. Hebdomadaire, 25 Sept., 2 Oct., 1868.

[12] Étude sur les fractures des cartilages du larynx, et leur traitement par la thyrotomie immédiate. Thèse de Paris, 1879.

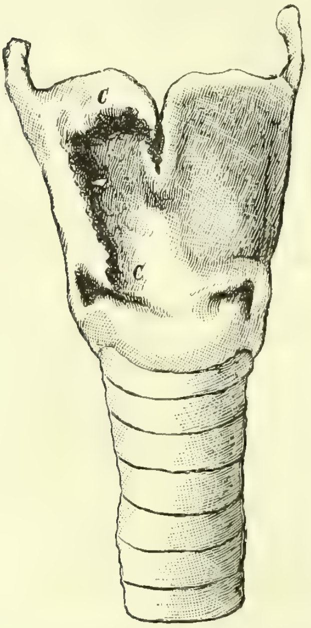
[13] Op. cit., 3d edit., vol. i. p. 749.

Ossification of the cartilages is hardly the important element in the injury that it was formerly supposed to be, for of 46 cases of fracture of the larynx and trachea collected by Gurlt,[1] 16 occurred in individuals between nine and thirty years of age, 12 in males and 4 in females. The thyroid cartilage alone was injured in 6 of these 16 cases, the cricoid alone in 1, the trachea alone in 1, the "larynx" in 2. Of the 27 cases collected by Hunt, 5 had occurred in children.

Fractures are sometimes associated with contused, incised, lacerated, and gunshot wounds of the integument and of the larynx itself.

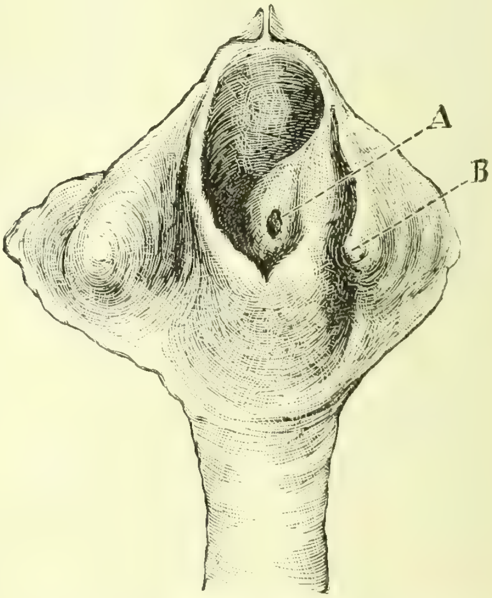
The *causes* of fracture of the larynx are attempts at choking with the hand, whether premeditatedly or during a struggle; blows with the fist, foot, or a hard weapon, such as a billet of wood; falls upon hard objects; awkward hanging;[2] and crushing violence. Mackenzie[3] records one from an acrobatic jump upon the patient's neck. Treulich records a multiple fracture in a patient whom a horse seized by the throat and lifted from the ground.

Fig. 1030.



Fracture of thyroid cartilage. *CC*, Line of fracture. (Roe.[4])

Fig. 1031.



Fracture of larynx. *A*, Rupture of mucous membrane where hemorrhage took place; *B*, Upper cornu turned inward. (Roe.[5])

Fracture of the *thyroid* may be single or multiple, complete or incomplete. The single fracture is usually vertical. Its most frequent seat is anteriorly, at the middle line or a little to one side, the intermediate cartilage usually adhering to the larger fragment (Fig. 1030). Multiple fractures may occur in one wing only or may involve both. Stellate fractures are sometimes produced by gunshot injuries.

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[1] Op. cit.

[2] For a recent example, see Porter, Archives of Laryngology, vol. i. p. 142 (illustrated).

[3] Op. cit., p. 402.

[4] Archives of Laryngology, April, 1881, p. 129.

[5] Ibid., p. 130.

Fractures of the *cricoid* cartilage are usually vertical or slightly oblique in direction. They may occupy the posterior, the lateral, or the anterior portion of the cartilage. They are usually single, but may be multiple. A case is recorded in which the cartilage was broken into three fragments.[1]

Fractures may be complicated by disrupture of the larynx from the trachea;[2] by œdema of the larynx or epiglottis;[3] by laceration or rupture of the mucous membrane (Fig. 1031); by displacement of fragments so as to occlude the calibre of the respiratory passage; by clotting of blood within it; in fact by nearly all the complications detailed in connection with contused, lacerated, and gun-shot wounds of the larynx.

A case has been recorded[4] in which blood was effused in the neighboring parts to such an extent as to push the larynx over to one side.

Symptoms of Fractured Larynx.—The symptoms vary with the cause of the injury and with the extent of the lesions. Unconsciousness is sometimes an immediate result, not only in cases of fracture from manual compression,[5] but in those from blows and falls upon hard objects,[6] and in those from fire-arms.

The ordinary subjective symptoms are pain, dyspnœa, and cough. The cough is usually spasmodic or paroxysmal, and serves to eject both frothy and coagulated blood, and bloody mucus. The dyspnœa is usually severe, and is attended with lividity of the countenance. It progresses in some instances to threatening suffocative apnœa, with all the usual accompaniments of that condition. Coarse mucous rales may be heard in the larynx. Dysphonia usually exists to some extent, in some cases amounting to aphonia. Difficulty of articulation occurs in some instances, and occasionally absolute inability to speak. Pain is usually excited by swallowing or by handling the part. Sometimes it is constant.

The dysphagia, as in Mackenzie's case,[7] which was examined laryngoscopically, may be found due to an inflamed and œdematous epiglottis.

In exceptional cases there may be but slight hoarseness, slight dysphagia, and slight pain or mere tenderness, with total absence of dyspnœa.

Should a laceration in the mucous membrane communicate with the site of fracture, emphysema of the throat and neck will be likely to occur. Such emphysema has been known to spread over the face, thorax, and back, down into the mediastinum, and even over the entire body. It is said to be more likely to involve the intermuscular connective tissue than that which is subcutaneous.

The suffocative symptoms may arise from serous œdema of the larynx, from hemorrhagic effusion, from accumulation of fluid or of clotted blood, or from occlusion by displaced fragments of broken cartilage and lacerated soft tissues. In some instances there has been but little dyspnœa at first, or none at all, and yet severe dyspnœa has suddenly ensued within a few hours, or as late as after several days of comparatively quiescent respiration. These manifestations have been attributed to œdema in some instances, and to displacement of fragments in others.

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[1] Treulich, Vierteljahrschrift f. d. prakt. Heilkunde, Bd. v. S. 129. 1876; Centralbl. f. Chir. 1876, No. 14.

[2] Wagner, Centralbl. f. Chir. 1883, No. 23.

[3] Mackenzie, op. cit., p. 402.

[4] Stokes, Dub. Jour. Med. Sci., May, 1869; cited by Durham.

[5] Wagner, Centralbl. f. Chir., 1883, No. 23; London Med. Record, October 15, 1883.

[6] Roe, loc. cit.; Sajous, Archives of Laryngology, July, 1882.

[7] Op. cit., p. 402.

The symptoms of incomplete fracture appear to be very slight in comparison to those of complete fracture. Although there is no absolute displacement of fragments, crepitus is said to have been elicited in some instances, when the parts were pressed upon for the purpose.

Diagnosis.—The history of wound or other injury, and the manifestations described as the symptoms, will indicate the character of the lesion. If the injury be the result of a direct blow or a fall, the neck may be flattened anteriorly; if the result of choking or other form of strangulation, it may be flattened laterally. Some evidence of bruise, contusion, or external wound is usually observed. Ecchymosis is commonly present, with tumefaction externally. Early swelling is attributed to extravasated blood; late swelling to inflammation. Abnormal mobility of the cartilages can usually be detected on manipulation. In severe lesions there may be deformity from overriding of the fragments. In others, there may be no displacement at all. (Gibb.) Crepitation may be produced by manipulation of the fragments in some instances; but care must be taken not to be deceived by the crepitation normally produced by lateral movements of the larynx, or by slight pressure against the vertebral column. The horn of the right cartilage may be anomalously inclosed in the lateral thyro-hyoid ligament,[1] or may be entirely absent.[2]

Prognosis.—The prognosis is always grave, especially so when the *cricoid* cartilage has suffered fracture. But two instances of recovery after fracture of the cricoid seem to be on record.[3] In the entire 28 instances of fracture of this cartilage tabulated by Durham,[4] not one patient recovered. Wagner's cases[5] furnish additional examples. The fatal result is probably attributable to the great contusion and laceration sustained by the bloodvessels, nerves, and other soft parts, in an injury sufficiently severe to fracture this very strong cartilage. Fractures of the *thyroid* cartilage are usually fatal, only 10 patients having recovered in Durham's list of 30 cases of fracture of that cartilage only, and 2 in 4 cases of fracture of the thyroid complicated with fracture of the hyoid bone. Guanck's case[6] also terminated fatally. A patient referred to my clinic from the surgical out-door department of Jefferson College Hospital, and placed under care of the clinical chief, recovered with a weak voice—crepitation being reported to have been as distinct four months after the injury as it had been on its receipt.[7] Harrison[8] likewise reports a case which terminated favorably. In Treulich's case of recovery,[9] there had been fracture of the thyroid and double fracture of the cricoid, with rupture of the trachea. It is presumable that the repair is by fibro-cartilage as in other wounds of the same parts.

Severe cases often terminate fatally at once, or within a few hours; usually by suffocative apnœa from extravasation of blood beneath the intra-laryngeal mucous membrane—hemorrhagic œdema—or from displacement of fragments occluding the calibre of the respiratory tract, or from accumulation of blood within it. Extensive injuries to the superjacent soft parts, or to other portions of the body, help to exhaust the forces of the patient, and render the prognosis still more gloomy.

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[1] Luschka, Virchow's Archiv, 19 Marz, 1868, S. 478.

[2] Cohen (Mütter Lectures), Phila. Med. Times, April 12, 1873, p. 435; op. cit., p. 609.

[3] Treulich, loc. cit., cited by Ashhurst (Principles and Practice of Surgery, 3d ed. 1882, p. 351): The cricoid was fractured in two places, isolating the anterior median segment; Masucci, Arch. Ital. di Lar., Anno I., 1881–2, p. 108.

[4] Op. cit., 3d edit., vol. i. p. 749.

[5] Wien. med. Woch., 1 Sept. 1883.

[8] Lancet, June 1, 1882.

[6] Loc. cit.

[7] Sajous, Archives of Laryngology, July, 1882.

[9] Loc. cit.

Unless forestalled by precautionary tracheotomy and insertion of a tube, suffocative phenomena may intervene at any time from œdema, displacement of fragments, or occlusion of the calibre of the air-tube with blood-clots.

Recovery occupies a number of weeks. In complicated cases, three months or more may be consumed in the process.

Suppuration ensues during repair; and this may entail cicatricial stenosis. The injured cartilages may undergo necrosis in part, and the dead portions may be expectorated, or may be discharged externally.

Suppurative inflammation of the connective tissue sometimes follows the emphysema. Death has taken place in this way by mediastinal emphysema and secondary pericarditis;[1] by pleurisy from contiguity to the burrowing abscess; and by pneumonia (Wagner's case) and broncho-pneumonia.[2] Permanent hoarseness, or even aphonia may remain after recovery.

Treatment.—Recovery is so rare unless tracheotomy has been performed at some stage of the treatment, and the danger of sudden suffocative apnœa is so great under almost any other method of management, that prudence seems to suggest the propriety of a prophylactic tracheotomy in every instance, as a precautionary measure, for reasons mentioned in discussing the treatment of incised and gunshot wounds of the larynx (p. 641). Of the entire sixteen cases of recovery out of the sixty-nine tabulated by Durham, in nine the patients were saved by timely opening of the air-passage, and a tenth was restored by long-continued artificial respiration after tracheotomy, although he succumbed to broncho-pneumonia a fortnight later.[3] To this list of recoveries after tracheotomy, may be added the exceptional case of Treulich, already referred to.

Better far that an unnecessary tracheotomy should be occasionally performed without detriment to the patient, than that a number of cases should be allowed to terminate fatally for want of it.[4]

The safety of the patient from suffocation being apparent, or having been secured by the operation recommended, the displaced fragments should be carefully adjusted, the crico-thyroid membrane being incised, if necessary, to facilitate their reposition by means of catheters, probes, or the little finger passed through the artificial opening—a procedure which practically adds nothing to the peril of the patient. No attempts should be made to retain the fragments in position by sutures, for reasons previously mentioned (p. 642). Any wound in the soft parts may be closed by sutures and adhesive strips; an opening being left for drainage, and kept patulous by a strip of lint or a drainage-tube. The treatment of emphysema and other complications, and the after-treatment altogether, should be conducted on the same principles as that of wounds of the larynx generally.

If the fragments of the thyroid cartilage fail to unite, or if stenosis cannot be prevented, extirpation of the partially detached portion, and even removal of half of the larynx has been suggested;[5] and in a case reported by Billroth, this partial operation was performed, and a good voice retained.

Fractures of the Trachea.—Fractures of the cartilages of the trachea occur under similar conditions to those under which fractures of the larynx are met with. In some instances the injury is confined to the trachea; in most it is associated with fracture of the larynx, of the hyoid bone, or of both. Gurlt[6] records nine cases of fracture of the trachea, in four of which that structure alone was involved. Dr. Corley[1] records a case following a squeeze of the throat in a domestic quarrel, in which three of the upper rings of the trachea had suffered fracture. A comminuted fracture is reported by Drummond,[2] in which the cartilaginous rings were crushed by a fall upon the exposed spindle of a chair from which the upper rung was missing.

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[1] Steiner, Wien. med. Woch., Bd. xviii. S. 15. 1867,

[2] Couper, Med. Times and Gaz., Dec. 18, 1880, p. 695.

[3] Op. cit., 3d edit., vol. i. p. 750.

[4] See especially Fredet, op. cit., p. 5.

[5] Wagner, loc. cit.

[6] Op. cit., S. 316.

Symptoms.—These are similar to those of fracture of the larynx: severe dyspnœa and rapidly extending emphysema. There is no elevation of dislocated fragments, no abnormal mobility, and no crepitation. False crepitus may be due to emphysema or to extravasated blood.

Diagnosis.—The character of the accident occasioning the dyspnœa and emphysema, and the evidence of external injury, will commonly indicate the nature of the case; but the absence of the physical signs of crepitus and deformity may render the diagnosis difficult.

Prognosis.—This is unfavorable, especially if the trachea be not freely opened for re-establishment of the respiration. Fracture of the trachea seems more promptly fatal than fracture of the larynx. Of seven cases collated by Gurlt, death followed in five of them from an hour and a half to a day after the accident. In one only was life saved, and then by tracheotomy after apparent death, the accumulated masses of blood and mucus being removed, and artificial respiration instituted. Recovery ensued in the case of comminuted fracture recorded by Drummond.

Treatment.—This is similar to the treatment of fracture of the larynx. The trachea should be laid freely open, either at the injured part or below it, and a tube inserted, through which respiration may be carried on with safety. The subsequent treatment should be like that adopted for similar wounds of the trachea.

TRACHEOCELE.

Tracheocele is the term applied to a sacciform diverticulum of the mucous membrane of the trachea[3]—a hernial protrusion externally, between two of the cartilaginous rings or through a congenital fistula. A tumor is thus formed on the external wall of the air-tube, the contents being air, and the cyst-wall mucous membrane. Its position may be anterior or lateral. The lesion is quite rare. The tumors vary in size from the bulk of peas (Gross) to that of hens' eggs. The tumor is usually single; occasionally it is bi-lobed. Faucon[4] relates one instance of ten years' standing, in which the tumor was divided into an upper and a lower lobe. Devalz[5] narrates a case in which the tumor was composed of two principal lobes; one passing under the muscles of the neck to the right, and the other under the clavicle to the left. Eldridge[6] likewise records a bilateral case. In a thoughtful article he presents a table of nine cases, two of which, however, were not really tracheoceles, and were not so recorded by their observer.[7] Détis[8] reports a case of median tracheocele in the practice of Godefroy, and reproduces eight cases published by other writers.

Tracheocele has been observed much the more frequently in males, and usually in the adult. Leriche[9] has recorded a case of double tracheocele in an infant eight months of age. Faucon[1] has recorded an instance in a child eighteen months old, in which the tumor was seen, during a plastic operation, to have been the result of a defect in the lining membrane of the trachea—the only instance of any anatomical examination of tracheocele with which I am acquainted. Imperfect descriptions of congenital examples have been recorded by Gohl[2] and by Fischer.[3] Gohl's case was associated with bronchocele.

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[1] Dub. Jour. Med. Sci., October, 1877, p. 346.

[2] Brit. Med. Jour., Dec. 28, 1872; Boston Med. and Surg. Jour., Jan. 16, 1873, p. 72.

[3] Rokitansky, Manual of Pathological Anatomy, vol. iii. p. 48. Philadelphia, 1855.

[4] Gaz. des Hôp., 1874, p. 77.

[5] Gaz. Hebd., 24 Juin, 1873, and Gaz. Méd., 15 Nov. 1873, p. 612.

[6] Am. Jour. Med. Sci., July, 1879, p. 70.

[7] Cohen, Diseases of the Throat, etc., p. 395. 1872.

[8] Contribution à l'étude du trachéocèle. Thèse de Paris, 1882.

[9] Comptes-rendus de la Soc. des Sciences Méd. de Lyon, 1868; reproduced by Détis, loc. cit.

Under the title of *aerial or vesicular goitre*, Larrey[4] has mentioned some cases of what appears to have been circumscribed emphysema of the neck, occurring in the blind Muslimim who chant verses of the Koran every hour from the tops of their minarets—the pouches being compared to the submaxillary pouches of monkeys. He also mentions two cases in drill-sergeants. A number of similar cases, with aerial tumors more or less evanescent, are recorded by various observers as having followed straining of the voice, violent cough, violent vomiting, and violent physical effort while holding the breath, two instances of this kind being mentioned in my work, already quoted.[5] But these are not cases of tracheocele, since there is no evidence of the existence in them of a sac formed at the expense of the mucous membrane of the trachea, which seems necessary to constitute that affection.

Pathogenetically, tracheocele seems due in most instances to a congenital defect in the closure of a branchial cleft. Through the fistula thus left, the tracheal mucous membrane is forced by the expulsive power of the expiratory current of air in violent coughing, or in straining with closed glottis. The sac produced in this way gradually enlarges, and is presumed to undergo thickening by inflammatory processes. Laceration of the air-tube in violent efforts with closed glottis, as during defecation and parturition, has been regarded as a cause of this affection, but it is not improbable that a congenital defect may have existed even in those instances in which such laceration has occurred.

Symptoms.—The subjective symptoms are dyspnœa, occasionally noisy and sometimes threatening in character; a hoarse, low, muffled voice; and aphonia and even dysphagia in some instances. In Devalz's case the pronunciation of each syllable was accompanied by a peculiar cooing, said to be faithfully imitable by pronouncing *ouvouvou* in a very deep tone.

The objective symptoms are connected with the presence of a compressible, gaseous tumor, sometimes resembling a cystic goitre, just above the sternum or not higher than the cricoid cartilage, whether anterior, lateral, or bilateral. This tumor enlarges somewhat during the expiratory phase of the respiratory act, and conversely diminishes in size during inspiration. Marked enlargement can be produced on forced expiration with closed mouth and nose, but this enlargement is much less than that observed to take place during a paroxysm of intense dyspnœa. In some instances the tumefaction is paroxysmal for some months before it becomes constant.[6] Laryngoscopically, the action of the laryngeal muscles has been seen to be sluggish (Eldridge), and this condition may partly account for the enfeeblement of voice. In other instances (Devalz), laryngoscopy has shed no light on the case.

Diagnosis.—The history of the sudden appearance of the tumor, its gradual enlargement, its increase under the force of the expiratory current of the breath, the control of some of this enlargement by exercising deep pressure at some point of the base of the tumor, the emphysematous sensation of crepitus on pressure of the mass, and its diminution or disappearance under equable compression, all point to the nature of the lesion. Palpation gives the sensation of a sac containing air.[1] Auscultation may reveal the normal tracheal murmur. (Devalz.) Tympanic resonance may be elicited on percussion in some cases. (Faucon, Lize, Détis.[2]) Tracheocele may be mistaken for goitre. The distinction could be made by an exploratory puncture, for in Eldridge's case the needle gave exit to a stream of air forcible enough to extinguish a lighted match. Discrimination from circumscribed emphysema would depend chiefly on the discovery of a sac by palpation, but the distinction from emphysema resulting from rupture at the summit of the lung, as in Lize's case, might prove difficult.

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[1] Loc. cit.

[2] Ammon, Die angebornenen chirurgischen Krankheiten des Menschen. Berlin, 1842; cited by Eldridge (loc. cit.).

[3] Pitha und Billroth, Handbuch der Chirurgie., Bd. III. Lief. i. S. 3.

[4] Clinique Chirurgicale, tome ii. p. 81. Paris, 1829.

[5] Diseases of the Throat, etc.

[6] Eldridge's case, loc. cit.

Prognosis.—This is said to be favorable by Détis, who reports a case cured after six weeks' compression. Other records seem to indicate the hopelessness of doing much more than preventing increase of size. No danger to life, however, is to be apprehended. The supposed cures have occurred in cases of emphysema rather than of tracheocele.

Treatment.—The treatment should consist in manipulation of the tumor, so as to drive as much air as possible out of it into the trachea, followed by the application of continuous pressure at the seat of control of the expansion of the tumor, so as to excite obliterative inflammation in the neck of the sac at the tracheal orifice. Dyspnœa may require special treatment by anodynes. Godefroy cured his patient within six weeks by permanent compression with a sort of hernia-bandage, and Leriche[3], too, promptly cured his patient by compression. Others have simply advised the use of an apparatus, to hide the deformity and prevent any further distension of the sac.

LUXATION OF THE CARTILAGES OF THE LARYNX.

Luxation of the cartilages of the larynx is rare. The cause may be traumatic, and proceed from without, or may be pathological, and proceed from within.

From without, it is the result of direct violence; in most instances, perhaps, associated with fracture of the larynx. Disarticulation of an *arytenoid cartilage* from the cricoid is the most usual form of the lesion. Disarticulation of the lower horn of the *thyroid cartilage*, in connection with other lesions, has been recorded by Holden[4] and mentioned by Mackenzie,[5] the cause in the former instance having been a severe blow or kick during a drunken brawl, and in the latter instance an accidental blow with the side of the hand.

From within, the cause is usually cicatricial contraction of the overlying or adjacent soft parts. In two instances, reported by Stoerk,[6] of luxation of the left arytenoid cartilage transversely inwards, the lesion was observed in adult males with falsetto voices, and in both the dislocated arytenoid was seen laryngoscopically to be immensely tumefied, the opposite cartilage being pushed out of position. The vocal bands were seen to be permanently in the position occupied in paralysis of the posterior crico-arytenoid muscles. One case was attributed to cicatricial contraction after diphtheria; but no assignable cause could be detected for the other. A case supposed during life to have been one of paralysis of the muscles mentioned, was discovered after death to be one of dislocation of both arytenoids on the interior surface of the plate of the cricoid cartilage, their bodies lying horizontally, and being closely united by cicatricial tissue.[1] In this instance, likewise, the lesion was attributed to contraction of a syphilitic cicatrix in the posterior wall of the larynx. As far as these meagre records are available, they seem to indicate that cicatricial contraction of an ulcer may be regarded as a cause of the dislocation.

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[1] Faucon, Eldridge (loc. cit.).

[2] Op. cit.

[3] Détis, op. cit.

[4] Am. Jour. Med. Sci., Jan. 1873, p. 129.

[5] Op. cit., p. 541.

[6] Wien. med. Woch., No. 50, 1873; London Med. Record, May 15, 1879.

Judging from the laryngoscopic image alone, unsupported by post-mortem evidence, or by the published observations of other writers, it has seemed to me that luxation or subluxation of a *supra-arytenoid cartilage* is an accident of occasional occurrence. In several subjects, principally singers who have become hoarse after unusual vocal exertion, I have noticed the supra-arytenoid cartilage of one side to incline decidedly forward and inward, in marked contrast to the erect position of the cartilage of the other side. The lesion does not seem to be of any special significance.

Symptoms.—The symptoms of dislocation of an arytenoid cartilage are not characteristic. They comprise difficulty in respiration and in phonation, with other manifestations due to the concurrent injury or disease which has occasioned the lesion. The symptoms described in Holden's case of dislocation of the inferior cornu of the thyroid cartilage—namely, acute pain, sense of suffocation, hemorrhage, dyspnœa, dysphagia, and aphonia—are indicative of concurrent contusion of the larynx.

Diagnosis.—As reported in the three instances cited, the laryngoscopic image in dislocation of the arytenoid cartilages presents a close resemblance to that of paralysis of the dilating muscles of the larynx; a circumstance which might be regarded as liable to induce a mistake in diagnosis, were it not for the recognition of the displacement of the cartilage. The diagnosis must rest chiefly on laryngoscopic inspection, in cases of internal origin, and on direct inspection and palpation in cases of external origin. In Holden's case of dislocation of the inferior cornu of the thyroid cartilage, the point stuck out so as to present a prominence readily recognized.

As the result of ulcerous processes in tuberculosis, in typhosis, and in syphilis, an arytenoid cartilage may become detached from its seat, and hang over into the interior of the laryngeal tube; but this is hardly a luxation in the strictly surgical sense of the term.

Prognosis.—The prognosis as regards reduction of the dislocation of an arytenoid or supra-arytenoid cartilage is unfavorable. As regards the life of the patient, it depends upon the position occupied by the displaced cartilage. If it occlude the glottis, tracheotomy and permanent retention of the canula may readily become necessary to insure due freedom of respiration. The prognosis in dislocation of the inferior cornu of the thyroid cartilage seems to be unfavorable, likewise, judging from the record of Holden's case, in which attempts at reduction were unavailing.

Treatment.—A dislocated cartilage, complicating a gunshot wound or a fracture of the larynx, should be removed, as there are no means of retaining it in position. In cases similar to those cited in the text, tracheotomy might be required, as mentioned under the heading of prognosis. In case of dislocation of the horn of the thyroid cartilage, attempts might be made to retain the parts in apposition by a compress and bandage, or by traction with adhesive strips.

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[1] Sidlo, cited by Ziemssen (Cyclopædia of the Practice of Medicine, vol. vii. p. 968. New York, 1876).

FOREIGN BODIES IN THE AIR-PASSAGES.

Water, food, or mucus, frequently, and something that should not have been put in the mouth, occasionally, "goes the wrong way," or gets into the air-tube, when one laughs, coughs, talks, cries, or makes a sudden inspiration, with any of these things in the mouth. Ordinarily the substance is ejected in a fit of coughing, and the accident passes out of remembrance with a laugh and a sense of relief. When any difficulty occurs in thus ejecting the intruding substance, the individual, often an infant, is slapped on the back by a bystander, the head and chest being bent strongly forward; and then the matter is ejected by the combined agencies of succussion, cough, and gravity. In very many instances, however, and especially when some substance, foreign in the literal sense, is in the mouth, the intruder is not dislodged so readily, but remains temporarily or permanently imprisoned in the air-passage. It may be loosely confined, or may become firmly impacted, whether in the larynx, the trachea, or a bronchus; and if not released, it may suffocate the patient at once, or at any subsequent period, varying within the extreme limits of minutes or of years.

Foreign bodies gain access to the air-passage in diverse manners, both by way of the natural orifice, and by way of a perforation through its walls, whether from the exterior of the body or from the interior.

FOREIGN BODIES INTRODUCED BY THE NATURAL ORIFICE.—Sudden inspiration, whether voluntary, incautious, accidental, or forced, while a mass of food or a movable foreign substance is in the mouth, is by far the most frequent source of the entrance of foreign bodies into the air-passages. Among other substances thus introduced, the following may be enumerated: water, going down the wrong way;[1] detached plates with artificial teeth;[2] matters vomited during repletion,[3] epileptic seizure,[4] apoplexy, unconsciousness and paralysis,[5] or anæsthesia;[6] regurgitated chyme,[7] curdled milk,[8] or meconium; parasites from the alimentary tract,[9] or from the nasal passages and adjoining sinuses; leeches carelessly applied to the mouth,[10] or inhaled while drinking from a fountain, stream, or hydrant;[11] teeth dislodged or crushed into fragments during extraction,[1] or during operations upon the mouth;[2] false teeth[3] or tobacco quids,[4] dislodged during anæsthesia; unsecured corks, inserted to keep the jaws separated;[5] sponges, detached in whole or in fragments[6] during operations within the mouth or upon the air-passages;[7] pus escaping from tonsillar,[8] post-pharyngeal, and aryteno-epiglottic abscesses;[9] blood from pulmonary hemorrhages, and from operations about the mouth[10] and upper air-tract; detached pseudo-membranes; instruments broken off during operations on the larynx;[11] necrosed laryngeal cartilages;[12] necrosed nasal,[13] palate,[14] and cranial[15] bones; illy made or corroded tracheotomy-tubes.[16] Finally, the epiglottis impacted into the upper orifice of the larynx may be mentioned as an occasional foreign body.[17] This accident usually occurs during eating, but may occur during the deglutition of saliva.

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[1] Monteggia, Inst. Chirurg., cited by Guyon (Dictionnaire Encyclopédique des Sciences Médicales. Art. Larynx, p. 707. Paris, 1876); by Poulet (Treatise on Foreign Bodies in Surgical Practice, vol. ii. p. 5. New York, 1880); and by others—a fatal case.

[2] Craigie, Edinburgh Med. and Surg. Jour., vol. xlii. p. 105. 1834; Wallace, Boston Med. and Surg. Jour., vol. xvi. p. 205. 1837; Carpenter, Guy's Hospital Reports, 1st series, vol. vii. p. 353. London, 1842 (cited by Gross, Foreign Bodies in the Air-Passages. Philadelphia, 1854); Major, Case of tooth and plate in the trachea for 113 days. Archives of Laryngology, October, 1882, p. 350.

[3] Ryland, Diseases and Injuries of the Larynx and Trachea, p. 198. Philadelphia, 1838—fatal case; Vidal (de Cassis), a fatal case, cited by Poulet (op. cit.). This patient had attempted to suppress emesis by putting his hand in front of his mouth.

[4] Dub. Jour. Med. Sci., March, 1881, p. 243—fatal cases.

[5] Barnes, Brit. Med. Jour., March 25, 1871, p. 321; Ibid., September 16, 1876, p. 381—fatal cases.

[6] Smyth, Lancet, October 3, 1874; Howse, Brit. Med. Jour., September 16, 1876, p. 16—fatal cases; Sands, Briddon, New York Med. Jour., October 20, 1883, p. 448.

[7] Parrot, Union Méd., No. 91, p. 167. 1868; Gaz. Hebd., p. 489. 1868; and a second case, Lancet, September, 1873.

[8] Warren, New York Med. Jour., May, 1882, p. 478 (illustrated)—fatal case.

[9] Aronssohn, Archives Gén. de Méd. 1836, t. x. p. 44, cited by Durham (op. cit., Am. ed. vol. i. p. 703); Fuerst, Wien. med. Woch., No. 3, 1879—a fatal case; Norman, Norsk. Mag. f. Lægevidenskaben, 3 R., Bd. xi.; London Med. Rec., March 15, 1882, p. 96—fatal case, attributed to croup.

[10] Guyon, Éléments de Chirurgie Clinique. Paris, 1873.

[11] Lacratelle, Gaz. de Santé, 25 Fev. 1828; Lancet, vol. ii., 1828, p. 104; Ridreau, Gaz Méd. de l'Algérie, 1869, Nos. 1, 2, *et seq.;* Massei, Il Morgagni, Ottobre, 1874, p. 750; Clementi, Gazz. med. Ital., 1874, No. 48; Arch. f. klin. Chir., Bd. xviii. H. 1, S. 194; R. de la Sota, Revista méd. de Sevilla, Nov. 1883, p. 20—the last four removed under laryngoscopy.

FOREIGN BODIES INTRODUCED BY WAY OF THE WALLS OF THE AIR-TUBE.—Foreign bodies may gain access to the air-passage from the outside, both by direct penetration, as in the oft-cited case of La Martinière,[18] in which a pin attached to a whip-cord had penetrated the trachea; and by indirect transit, as in gunshot wounds (see p. 634). Fauvel[19] has recorded at length an instance in which a bullet, that had lodged originally somewhere in the bones of the face, was found in the larynx ten years afterwards, and was spontaneously expelled from the left pyriform sinus. Tauber[20] removed a bullet from the same locality twelve years after a gunshot wound of the neck.

Wounds and perforations of the trachea and bronchi occasionally afford opportunity for the entrance of a foreign body. Fluids are the most frequent substances, but cases are known of penetration into the trachea of a foreign body from the œsophagus,[1] of a necrosed portion of the sternum,[2] of diseased bronchial glands,[3] of pulmonary abscesses,[4] of the contents of tuberculous cavities,[5] of purulent pleural effusions,[6] and of blood from pulmonary hemorrhages and aneurisms; cases are also known of ulceration into a bronchus[7] of a bronchial gland, of escape of food from an œsophago-tracheal perforation,[8] and of foreign bodies introduced by wound or disease into the thoracic cavities—including bullets, clothing, fragments of bone, fragments of a watch-movement, and pieces of glass.[9]

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[1] Hertz, Dental Cosmos, 1873, p. 478; Hospital Gazette, October 4, 1879, p. 496; Med. Record, November 4, 1882, p. 517.

[2] Aronssohn, cited by Poulet (op. cit.)—a fatal case.

[3] Chaffers, Brit. Med. Jour., April 20, 1872, p. 49.

[4] Fischer, Deutsche Ztsch. f. Chir., Bd xv. S. 188.

[5] Medical and Surgical Reporter, 1867; Agnew, Principles and Practice of Surgery, vol. iii. p. 45. Philadelphia, 1883.

[6] Mears, during excision of the tongue; life saved by immediate tracheotomy. (Personal communication.)

[7] Cohen, op. cit., p. 572.

[8] Stokes, Med. Times and Gaz., August 29, 1874, p. 251—a fatal case; Littlejohn, Brit. Med. Jour., January 2, 1875, p. 161.

[9] Vidal (de Cassis), cited by Poulet (op. cit.)—fatal case.

[10] Freeman, Practitioner, Aug. 1883, p. 119.

[11] Schroetter, Monatschr. f. Ohrenheilk., Bd. x. 1876, cited by Poulet—the hair from a brush; Voltolini, ibid., Dec. 1879, and London Med. Record, July 15, 1880, p. 293—ends of a pair of laryngeal forceps, retained nine months.

[12] Hunter, O'Shea, Labbé, Bell, Gooch and Houston, Larrey (cited by Poulet); Chvostek, Centralbl. f. d. med. Wiss., 30 Dec. 1882, and Amer. Jour. Med. Sci., April, 1883, p. 581.

[13] Lincoln, Archives of Laryngology, July, 1882, p. 276.

[14] Brit. Med. Jour., 1873, cited by Poulet.

[15] Coupland, Lancet, May 31, 1884, p. 984—fatal case.

[16] This source of the accident, so readily avoided by proper circumspection and admonition, is so inexcusable that I desire to emphasize the point with quite an array of references: Porter, On the Larynx and Trachea, p. 144. London, 1837; South, Chelius's Surgery, Am. ed., vol. iii. p. 116, cited by Gross (op. cit., p. 325); Albers, Arch. f. klin. Chir., Bd. viii. S. 177; Waters, Brit. Med. Jour., February 15, 1868, p. 141; Masing, St. Petersb. med. Ztsch., H. 7, 1869—four years' detention; Boston Med. and Surg. Jour., February 23, 1871, p. 128; Buck, Trans. New York Acad. Med., 1870; Pick, Trans. Path. Soc. Lond., 1870, p. 416; Ogle, Med. Times and Gaz., November 5, 1870, p. 531; Holthouse, Lancet, January 27, 1872, p. 113; Ogle and Lee, Lancet, January 20, 1872, p. 81; Med. Times and Gaz., September 21, 1872, p. 324; Hulke, Lancet, December 2, 1876, p. 785; Davy, Brit. Med. Jour., July 8, 1876, p. 45; Burow, Berliner klin. Woch., No. 36. 1876; Thornton, On Tracheotomy, p. 36; Howse, Lancet, April 17, 1877.

[17] Ruehle, Die Kehlkopfkrankheiten, S. 13. Berlin, 1861; Cohen, op. cit., p. 615; Agnew, op. cit., vol. iii. p. 45.

[18] Mém. de l'Acad. de Chir., t. v, p. 521.

[19] Revue mensuelle de Laryngologie, etc., Octobre, 1881, p. 395.

[20] Archives of Laryngology, January 1, 1881, p. 62.

Many cases of foreign body in the air-passage occur in children having their playthings in their mouths. Many of these accidents take place while the individual is drinking, laughing, coughing, or talking. In another group of cases, the sudden inspiration which drives the substance into the air-tube is produced by a startling blow, a slap on the back, or even by tickling the neck.[10] An experimental effort to sound a whistle by an inspiratory effort, has driven the loose reed into the left bronchus.[11] Suction sometimes detaches the mouth-piece from a feeding-bottle, and draws it into the air-passage.[12] A curious case has been recorded in the daily papers, of suffocation from a kernel of corn, driven into the windpipe of a man by the cough of a feeding horse.[13] The variety of objects which produce the accident seems endless,[14] embracing anything from a bean or a grain of corn—which, according to the researches of Weist,[15] is the most frequent object in America—to a toy locomotive[16] or the larynx of a goose.[17]

The subjoined classification by Poulet,[18] based on Bourdillat's statistics, which include more than three hundred cases, shows concisely the variety of substances which have given occasion to the accident. Some additions have been made towards completing the list:—

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[1] Vigla, Bégin, and others (Guyon, Dict. Encycl. des Sci. Méd., art. Larynx, pp. 705, 706; cited by Durham and by Poulet); Goll, Centralbl. f. Chir. No. 3, 1879; Castle.

[2] Bérard, Thèse de Paris, 1840; cited by Guyon and by Poulet.

[3] Kjerner, Hygiea; Nordiskt med. Ark., VI., No. 1; New York Med. Jour., August, 1875, p. 206—a fatal case; Goodhart, Brit. Med. Jour., April 12, 1879, p. 542.

[4] Canada Jour. Med. Sci., July, 1882, p. 238—a fatal case.

[5] Geoghegan, Vigla; cited by Guyon (loc. cit.) and by Poulet (op. cit., p. 11)—fatal cases.

[6] Canada Jour. Med. Sci., July, 1882, p. 238.

[7] Edwards, Med.-Chir. Trans., vol. xxxvi.; cited by Durham, by Poulet, and by Mackenzie (op. cit.). The detached gland became impacted in the rima glottidis, having been expelled from the bronchus up the trachea during violent exertion.

[8] Castle, Medical News, March 15, 1884, p. 300.

[9] Poulet, op. cit., p. 22.

[10] Benoit; cited by Guyon and by Poulet.

[11] Aronssohn, loc. cit.; cited by Poulet.

[12] Bordley, Am. Jour. Med. Sci., January, 1877, p. 271; Med. Times and Gaz., March 18, 1882, p. 295.

[13] Chicago Times; and Philadelphia Times, December 28, 1879.

[14] See Gross, Foreign Bodies in the Air-passages. Philadelphia, 1854; Poulet, Treatise on Foreign Bodies, vol. ii. New York, 1880.

[15] Weist, Trans. American Surgical Association, vol. i. Philadelphia, 1883.

[16] Johnston, Archives of Clinical Surgery, December, 1876 (illustrated).

[17] Burow, Casper's Woch.; Brit. and For. Med.-Chir. Rev., 1850; London Medical Gazette, 1850, cited by Gross (op. cit., p. 35).

[18] Op. cit., p. 22.

Inanimate,	Inorganic,	Solid,	Regular,	Beads; needles; coins and medals; buttons and button-moulds; bullets; pebbles.
			Irregular,	Surgical instruments; bullets; stones; toilet, shawl, and safety pins; fish-hooks; dress-hooks; pens; puff-darts; slate-pencils and lead-pencils; spikes, nails, and tacks; toys; artificial teeth, with and without blocks, pivots, and plates.
		Hollow,		Rings; beads; tracheotomy-tubes; hypodermic needle; pencil-cases; whistles; mouth-pieces; pipe-bowls and pipe-stems.
	Organic,	Solid,	Regular,	Pills; beans; peas; grains of corn and coffee; apple, melon, raisin, pumpkin, and other seeds; acorns; stones of the apricot, cherry, date, plum and prune, tamarind, and other fruits.
			Irregular,	Pieces of rubber; fragments of nuts; nut-shells; pieces of fruit, meat, and vegetables; masticated food; bones of quadrupeds, fish, and fowls; lobster claws; muscle, oyster, and clam shells; spikes of oats; ears of rye, wheat, and barley; cockle, beech-nut, and other burrs; blades of grass; leaves, wood, and bark; teeth; feathers; sponges; matches; fiddle-pegs; sealing-wax; brushes; charcoal; corks; linen and cotton cloth and thread; yarn and wool; blood-clots; detached cartilages, bronchial glands, or other tissues.
		Hollow,		Pierced fruit-stones; quills, goose's larynx; rings of bone; rubber mouth-pieces and tubing.
Animate,	. . . . . .	. . . . .	. . . . .	Worms; flies; leeches; hydatids; oysters; fish; bugs.

The majority of these substances are hard, and not likely to undergo change of size after impaction. Animal and vegetable substances, such as morsels of meat, beans, seeds, etc., may imbibe moisture and augment in size after incarceration. When retained for long periods, the foreign body may become incrusted with desiccated mucus and calcareous matter. Gross[1] mentions an instance, quoted from the Ephemerides, in which a concretion was formed as large as a nutmeg. The foreign body is usually single, but cases have been narrated in which from two to six substances, similar or diverse, have entered, either simultaneously or successively.[1]

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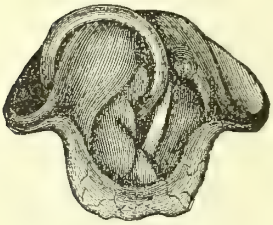
[1] Op. cit., p. 38.

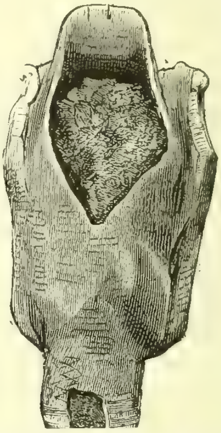
In some instances, the foreign body may be partly within the air-passage and partly without, as in the interesting case observed by Lefferts,[2] in which a brass ring had remained imbedded in the tissues of the larynx for four years, straddling the aryteno-epiglottic fold and ventricular band. (Fig. 1032.)

Fig. 1032.



Brass ring straddling the larynx. (Lefferts.)

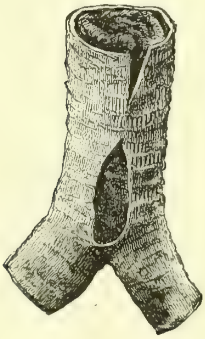
Fig. 1033.



Obstruction of larynx by a piece of boiled beef. (Poulet.)

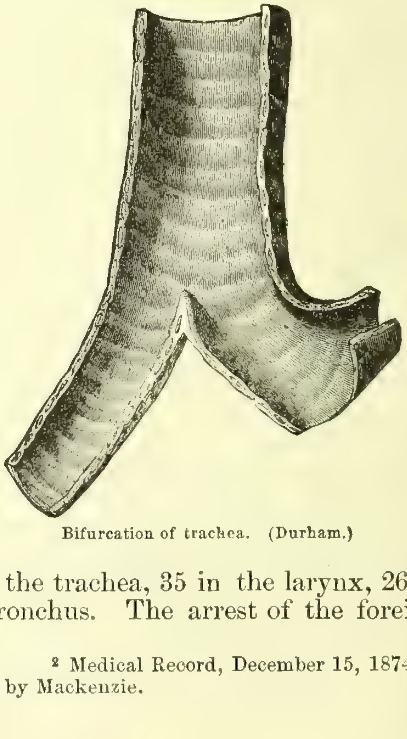
The foreign body may remain loosely imprisoned within the air-passage, or it may become impacted somewhere in the larynx (Fig. 1033), in the trachea (Fig. 1034), or in a bronchus. According to Bourdillat's statistics,[3] of 156 instances of impaction, 80 took place in the trachea, 35 in the larynx, 26 in the right bronchus, and 15 in the left bronchus. The arrest of the foreign

Fig. 1034.



Obstruction of trachea by pancake. (Poulet.)

Fig. 1035.



Bifurcation of trachea. (Durham.)

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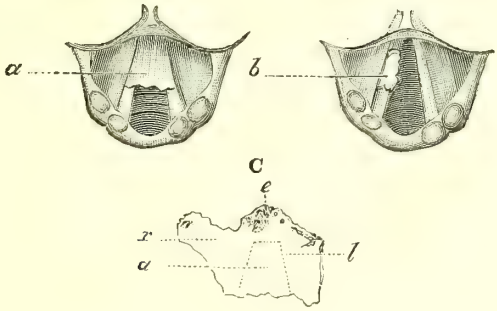
[1] Gross, op. cit., pp. 37, 38.

[2] Medical Record, December 15, 1874.

[3] Gaz. Méd., 1861, p. 135; cited by Durham and by Mackenzie.

body takes place in the right primary bronchus much the more frequently, because, as indicated by Gross,[1] the septum at the bifurcation is to the left side, and because the right bronchus is the more capacious (Fig. 1035). In some instances a foreign body has become arrested in each primary bronchus. In some it becomes arrested in one of the smaller bronchi.[2] If arrested in the larynx, it may become lodged in one or both ventricles[3] (Fig. 1036), or may become impacted between the vocal bands.

Fig. 1036.



Bone imprisoned in the ventricle of the larynx. (Mackenzie.)

A remarkable case of impaction in the posterior wall of the trachea, detected ten months after tracheotomy and the necessary retention of the canula, has been recorded by Voltolini,[4] an anterior concavity in the foreign body having permitted the passage of the canula, although it impeded respiration whenever the canula was withdrawn. A cleansing rod, allowed to slip through a tracheotomy wound, was detected by aid of a tracheal mirror,[5] and extracted with forceps during cough.

Occasionally a sharp foreign body in the larynx is forced through the tissues, soft and hard, to the exterior, whence it may be removed by integumentary incision;[6] even the head of a pin has been known to penetrate the crico-thyroid membrane in this way.[7]

Occasion has already occurred (p. 635) to notice a case in which the point of a dart penetrated the carotid artery, and produced fatal hemorrhage.

Sharp-pointed substances, such as needles and pins, sometimes become impacted in the tissues of the larynx without directly interesting the lumen of the air-passage. Thus a case has been recorded by Wheeler,[8] in which a threaded needle pierced an arytenoid cartilage; laryngoscopic inspection showing it to be fixed obliquely by the eye into the left palato-pharyngeal fold, and by the point into the arytenoid cartilage. Other efforts at extraction failing, pharyngotomy was performed and the needle extracted. A somewhat similar but still more remarkable case has been reported by Semon,[9] in which, with the aid of the laryngoscope, he removed a pin which for thirteen months had transfixed the left arytenoid cartilage and aryteno-epiglottic fold.

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[1] Op. cit., p. 46.

[2] Forbes, Med.-Chir. Trans., vol. xxxiii. p. 1; cited by Gross.

[3] Mackenzie, Trans. Path. Soc. Lond., vol. xviii., p. 27, and Diseases of the Throat and Nose, etc., vol. i. p. 417.

[4] Berlin. klin. Woch., 8 Februar, 1875.

[5] Schmidt, Arch. f. klin. Chir., Bd. xviii. S. 1.

[6] Wharton, Med. News, November 17, 1883, p. 541.

[7] Coomes, Med. and Surg. Rep., March 22, 1884, p. 363.

[8] Med. Press and Circular, April 22, 1875; cited by Poulet (op. cit., vol. ii. p. 80).

[9] Trans. Clin. Soc. Lond., vol. xvi.; Reprint, London, 1883.

Symptoms of Foreign Bodies in the Air-Passages.—The usual symptoms are a sudden paroxysm of pain, cough, sense of suffocation, and spasm of the larynx. The graphic description of a severe initial paroxysm given by Prof. Gross,[1] includes all the phenomena of impending suffocative apnœa: that is, surprise, gasping respiration, violent coughing, distressing cries, partial loss of consciousness, lividity of countenance, projection of the eyeballs, contortion of the body, external manipulation of the throat, exit of frothy mucus and even of blood from the mouth and nose, emesis, and involuntary discharge of feces and urine. The initial paroxysm may terminate fatally, or may pass off after lasting from a few seconds to several minutes, or even several hours, should the foreign body be arrested in the larynx. Subsequent paroxysms occur at intervals of minutes, hours, or days, varying with the nature of the foreign body, its location, and the constitutional proclivities of the individual. The same circumstances determine whether, during the intervals, respiration shall remain tranquil or be disturbed, cough be slight or severe, and the voice be natural or changed.

In many instances the symptoms are slight from the beginning. After the violent, initial paroxysm has subsided, they may be so slight as to furnish no special subjective manifestation whatever, even though the foreign body be deeply impacted in the larynx.[2] False security may be induced in this way, and a sudden change of the intruder's locality may suddenly threaten suffocation.[3]

Traumatism may ensue from angular and irregular bodies, and thus progressive inflammatory symptoms—cough, hoarseness and dyspnœa, with insomnia and anxiety—may become superadded to those already existing. These secondary symptoms are sometimes prolonged after the removal of the foreign body, continuing until the inflammatory complications and sequelæ have subsided. Should the position of the foreign body occlude the œsophagus, dysphagia may become added to the earlier symptoms, and marasmus to the later ones. Long-continued symptoms of obscure bronchial and pulmonary disease are sometimes indicative of the prolonged sojourn of an unsuspected or forgotten foreign body.[4] Hæmoptysis, dyspnœa, pyrexia, cough and expectoration, attributed to pulmonary tuberculosis, sometimes cease at once on expulsion of a foreign body from the air-passages.[5]

Diagnosis.—There is usually some history indicative of the lesion. In its absence, the suddenness of the symptoms may establish the diagnosis. As noted by Delasiauvé,[6] the diagnosis is difficult in the cases of epileptics. When the symptoms are slight and the history concealed, the case may be mistaken for one of laryngitis. A foreign body in the pharynx or œsophagus, if it occlude the air-passage or compress it, will give rise to most of the subjective and objective phenomena of a foreign body in that part. Discrimination is effected by digital exploration, and by the use of the bougie or probe. A bougie with a metallic tip will give a click, as it strikes the object.

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[1] Op. cit., p. 71.

[2] Whistler, Lancet, December 2, 1876, p. 779 (illustrated)—a bone impacted in the larynx for five weeks.

[3] Porter, Dublin Med. Press, February 9, 1859; cited by Mackenzie.

[4] Moore, Goodhart, Maclagan, Begbie, and Sharkey (Lancet, New York ed., February, 1883, p. 147); Coupland, Lancet, May 31, 1884, p. 984.—In this case a diagnosis had been made of pleurisy at the left base.

[5] Laborde, Gaz. Méd., No. 48, 1868, p. 701; Cohen, Trans. Path. Soc. Phila., vol. iv. p. 148.

[6] Poulet, op. cit., vol. ii. p. 17.

Laryngoscopic inspection will usually reveal the foreign body, if present in the larynx, and sometimes if in the trachea.[1] In children an anæsthetic may be used, and the jaws may then be separated, the tongue held forward, and the laryngoscopic inspection attempted—sometimes with success, usually without it. If symptoms of suffocation be urgent, tracheotomy should be performed before the inspection is made. Macnamara[2] saved a life in this way by tracheotomy, recognized a large piece of fat bacon laryngoscopically, and removed it.

Auscultation of the trachea will detect a loose body there. Auscultation of the lungs will detect impaction in a bronchus. Obstruction of the left bronchus usually produces absence of respiration over the entire lung of that side, but occlusion of the right bronchus usually produces absence of respiration over the lower lobe of that side only, the division of the bronchus taking place much nearer the bifurcation, and the foreign body rarely lodging above the point of division.

In deciding between the presence of a foreign body and disease, it is maintained that the increased effort in respiration in the case of a foreign body, as contrasted with the increased frequency in disease, will suffice for the discrimination.[3]

Prognosis.—The prognosis is serious. Although foreign bodies sometimes remain for years without producing much apparent injury,[4] their retention usually entails more or less of the following results: traumatic inflammation of the air-passage—which may be followed by œdema of the larynx, abscess, ulceration, gangrene, and necrosis—pneumonia, pulmonary abscess, pleuritis, pericarditis, hepatitis, or œsophagitis. On the strength of an autopsy in one of his own cases, Ingals[5] calls attention to the likelihood of heart-clot occurring as a result of obstructed respiration. Furthermore, fatal inflammation has resulted although the foreign body has been expelled spontaneously. In view of these facts it seems proper to remove the foreign body by surgical procedure if there is any likelihood of success.

Weist,[6] in an analysis of 1000 cases, gives 460 recoveries among 599 patients not operated on, or 76.79 per cent., against 245 recoveries among 338 operated upon, or 72.48 per cent. Much, however, depends upon the character of the cases. It is to be presumed that, as the rule, the severest cases have been treated by operation, and that the mildest ones have been treated expectantly. Should this have been the case, the recoveries would have been far more numerous had there been a greater proportion of operations. Dr. W. J. Smith[7] adds the statistics of Gross and Durham to those of Weist, and reverses his result; 283 deaths among 955 patients not operated upon, or 29.78 per cent., and 178 deaths among 719 operated upon, or 24.75 per cent.—the entire proportion being one death in 3.5 of the unoperated cases, and 1 in 4 of the operated. Durham's[8] statistics alone give a much better showing for the operation, 260 patients having recovered out of 338 operated upon, and only 176 out of 298 not subjected to operation. In a later table Durham[1] analyzes 212 cases of tracheotomy for foreign body, with 157 recoveries.

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[1] Major, of Montreal, detected a tooth and plate at the bifurcation. Archives of Laryngology, October, 1882, p. 351.

[2] Brit. Med. Jour., May 30, 1874, p. 714.

[3] Parke, Med. Times and Gazette, April 16, 1881, p. 429.

[4] Cameron, Liverpool Med. and Surg. Rep., October, 1870 (penny in larynx six years, seen laryngoscopically and removed with forceps); Cohen, op. cit., pp. 617, 619, and Trans. Path. Soc. Phila.; Semon, Brit. Med. Jour., April 21, 1883, p. 770. (A pin remained impacted in the larynx for thirteen months.)

[5] Independent Practitioner, June, 1882, p. 364.

[6] Op. cit.

[7] London Med. Record, June 16, 1884, p. 238.

[8] Op. cit., 3d ed., vol. i. p. 765.

When retained for a long time the foreign body may become encysted,[2] even in the lung substance.[3] Much more frequently it excites ulcerative inflammation, laryngitis, bronchitis, or pneumonitis, as may be, with gradual exhaustion from disease of the larynx, trachea, or lungs. Extreme tolerance is occasionally exhibited, however, as in a case reported by Franks,[4] in which a chicken bone measuring $1\frac{3}{8}$ inches, by $1\frac{1}{18}$ inches, by $1\frac{1}{16}$ inches, remained impacted above the vocal bands for twenty-three days.

Watson[5] cites an instance in which a piece of gold was lodged for years in one of the ventricles of the larynx, without distressing circumstances, and Gross[6] one in which a piece of bone was expelled in coughing after sixty years' retention.[7] When retained for some time, substances are not infrequently expelled spontaneously in fragments. Nuts, beans, coffee grains, and pills are ejected in this way, and even a hypodermic needle, inhaled by a physician who had placed it between his lips, was expelled in two pieces, after thirteen days' retention.[8]

The period at which spontaneous expulsion takes place, varies with the individuality of the case. In 136 cases of recovery summarized by Durham, expulsion took place immediately, or in less than twenty-four hours, in 6; in from one to eight days in 12; in from eight to thirty days in 19; in from thirty days to one year in 68; and in from one to seventeen years in 31.

In the great majority of instances, spontaneous expulsion is followed by recovery from all sequelæ, even though the expulsion have been delayed months, or even years.[9] Nevertheless, after the substance has remained in the air-passage for a number of months, death often follows spontaneous expulsion[10]—sometimes within a few days, and sometimes after prolonged suffering, extending over many months.

Treatment of Foreign Bodies in the Air-passages.—The spontaneous expulsion of foreign bodies by coughing, early suggested the administration of emetics and sternutories[11] for the purpose of exciting expulsive expiratory efforts. Theoretically there seems to be a risk run of producing sudden impaction at the chink of the glottis, as alluded to by all writers on the subject; but any recorded instance of life lost in this manner has escaped my research. The same remark is applicable to the apparently equally condemnable plan of inverting the body and slapping the patient on the back or on the chest. The generally received surgical opinion is that these measures, though often successful, are unjustifiable unless a preliminary incision has been made into the air-passage, or unless the surgeon is fully prepared to perform immediate tracheotomy on the occurrence of urgent symptoms. To favor expulsion by the method of inversion, the patient should be made to take a deep inspiration at the moment of inversion, and to follow this with a strong effort at expiration. At the beginning of the latter effort, a blow is to be given opposite the point at which the foreign body is believed to be lodged.

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[1] Ibid., p. 770.

[2] Gross, op. cit., p. 47.

[3] Durham op. cit., Am. ed., vol. i. p. 704.

[4] Archives of Laryngology, October, 1882, p. 352.

[5] Practice of Physic, 4th ed., vol. ii. p. 436; cited by Durham.

[6] Op. cit., p. 172.

[7] Bartlett, New York Journal of Medicine and the Collateral Sciences, vol. vi. p. 23. Ibid. p. 172.

[8] Sydney Jones, Lancet, August 7, 1880, p. 208.

[9] Heckstetter's case, and others, cited by Gross (op. cit., pp. 117–173); Elsberg, Phila. Med. Times, July 29, 1882, p. 729; Faught, Medical News, Oct. 13, 1883, p. 205.

[10] Gross, op. cit., pp. 173–182.

[11] Aetius, cited by Guyon (Bull. Gén de Thérap., 15 Janv., 1869, p. 15).

The smooth contour of pebbles, and the circular form of coins, whose weight and shape favor their obedience to the laws of gravity, favor their removal by the ingenious plan of Padley.[1] "A strong bench having been fixed with the legs of one end on a couch, and the other on the floor, the patient was made to sit on the upper part of it, with his knees flexed over the end. He was then directed to lie back upon the inclined plane thus formed, and, having done so, instantly raised himself up with the sixpence in his mouth. The supine position probably favored the exit of the coin, and the readiness with which, by his own effort—the knees acting as a fulcrum—he gained the upright position, would have saved him from the danger of spasm in the event of its non-expulsion."

Krishaber, having determined laryngoscopically the position of a metal-tag, turned a child over, inserted his finger into the larynx as a guide, and removed the substance with forceps.[2]

Should attempts at mechanical dislodgment by the methods described be deemed injudicious, or prove inefficient, there remain the methods of removal by extraction, sometimes performed by way of the natural orifice of the air-passage, and sometimes by way of an artificial incision from the exterior.

Extraction through the mouth may be performed under laryngoscopic inspection, or without it. In either case, whenever practicable, the position of the substance should be ascertained laryngoscopically before its withdrawal is attempted. Forceps and blunt hooks are the instruments usually employed in these manipulations. In many instances the ingenuity of the surgeon is taxed to devise some special instrument adapted to the case in hand. Thus Brandeis[3] removed a thread from the larynx by means of a brush dipped in mucilage.

Extraction by way of the natural passages, although successfully performed at times under very adverse conditions, seems justifiable, as a rule, only when the foreign body is situated above the vocal bands. If the foreign body be below the glottis, this procedure may be entertained only when the substance is of such a character that it will not be apt to strike those structures and injure them, or provoke spasm. Injury to the vocal bands may entail permanent impairment of voice. The cases in which jagged bodies, such as impacted portions of dental plates, have been forcibly torn from the larynx, lacerating vocal bands and other tissues[4] without permanently injuring the patient, should be regarded rather as lucky instances of the tolerance of the tissues, than as commendable evidences of the surgeon's skill. Small, slender, and regularly shaped substances, such as fish-hooks, needles, pins, coins, and leeches,[5] have often been safely extracted under laryngoscopy. Brittle substances such as bones and nutshells, when not likely to be withdrawn in bulk without tearing the tissues, should be broken in the blades of forceps, and, if not spontaneously coughed out, may then be removed in fragments. As one of the most recent examples of what can be done laryngoscopically, I reproduce from Grazzi[6] a sketch of the laryngoscopic image (Fig. 1037) of a coin impacted in the ventricles of the larynx, and a sketch of its appearance in the grasp of the slide-forceps (Fig. 1038) with which it was withdrawn.

When the impacted body is of such a contour as to prevent its ready extraction, it is far better practice to perform tracheotomy.[1] In some instances, tracheotomy having been performed, subsequent laryngoscopic manipulation may supersede the alternative of splitting the larynx, as in a case of bone impacted in the ventricles, under the conjoint care of Sir William Fergusson and Dr. Morell Mackenzie[2] (see Fig. 1036), in which, some days after the tracheotomy, the bone was dislodged with a blunt hook and expelled in two pieces, one in the grasp of the hook, and the other by coughing after similar dislodgment, the day following. In other instances, the extraction may be accomplished safely after awaiting subsidence of the local inflammation, as in a case in which a lamella of bone, measuring nearly one inch by three-fourths of an inch, was removed by Whistler[3] from below the vocal bands, six weeks after it had become firmly imbedded in the laryngeal tissues. These manipulations are performed with curved laryngeal forceps, one of the best of which is the lever-bladed forceps devised by Cusco. (Fig. 1039.)

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[1] Brit. Med. Jour., Nov. 6, 1878, p. 721.

[2] Annales des Maladies de l'Oreille, etc., 10 Mai, 1878.

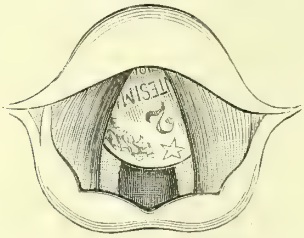
[3] American Practitioner, Nov. 1873, p. 317.

[4] Oppenheimer, New York Med. Jour., Sept. 1879, p. 398.

[5] R. de la Sota removed a leech from the uppermost ring of the trachea, with laryngeal forceps. El Anfiteatro Anatomico, No. 73, 1874; Archives of Laryngology, Jan. 1883, p. 17.

[6] Bollettino delle Malattie dell' Orecchio, della Gola, e del Naso, 1884, No. 4.

Fig. 1037.

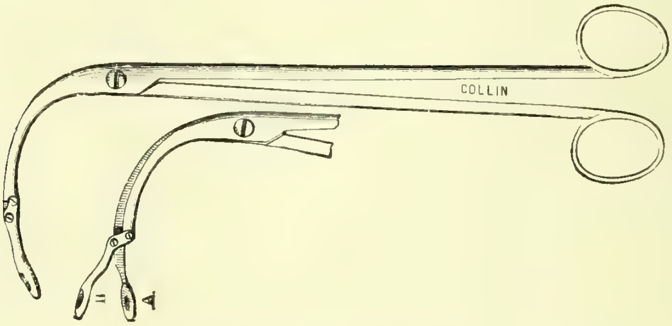


Coin impacted in the ventricles of the larynx. (Grazzi.)

Fig. 1038.

Coin in grasp of forceps. (Grazzi.)

Fig. 1039.



Cusco's lever-bladed laryngeal forceps.

Voltolini[4] has suggested the use of a powerful magnet, applied externally, to lift a needle, tack, or other object susceptible to magnetic attraction, out of the air-passage into the pharynx, or to fix it at a point accessible to laryngeal forceps, or to a magnetized probe. It is quite possible that a magnetic probe or pair of forceps introduced into the air-passage, whether laryngoscopically or through an external incision, might draw towards it any small body of this kind.

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[1] For cases in point, see Schmidt, Arch. f. klin. Chir., Bd. xvi. H. 1, S. 186; Cohen, op. cit., p. 620; R. de la Sota, Archives of Laryngology, Jan. 1883, p. 13.

[2] Op. cit., p. 417.

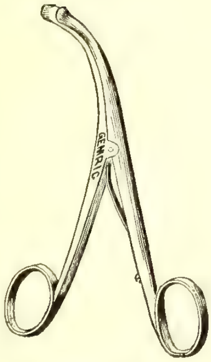
[3] Lancet, Dec. 2, 1876; cited by Mackenzie (op. cit., p. 416).

[4] Personal communication; and Trans. International Medical Congress of 1881, vol. iii. p. 334.

In the great majority of cases, however, it will be found necessary to make an artificial opening into the air-passage from the exterior.[1] The point at which the incision is to be made will depend on the subject to be operated upon, and on the character and position of the foreign body. If a large or irregularly shaped substance be impacted in the larynx, it may become necessary to divide the thyroid cartilage (*thyroidotomy*) to get proper access to it. Smaller and smooth objects may be reached through wounds in the crico-thyroid membrane only (*crico-thyroid laryngotomy*). In cases of foreign body in the trachea or bronchi of the adult, and almost always in children, tracheotomy is preferable to crico-thyroid laryngotomy, as affording greater freedom of manipulation for dislodgment. The incision should be about one inch long in the child, and an inch and a quarter in the adult. Very often the foreign body is ejected through the wound the moment after the air-passage has been opened. Sometimes it is ejected through the mouth. Sometimes it is driven to the orifice of the wound, whence it may be extracted with forceps. Should the foreign body fail to appear, the patient is to be turned over so that succussion may be tried to dislodge it. This failing, the surgeon may blow strongly into the trachea, so that the air, thus compressed, may become more expulsive in the cough which follows.

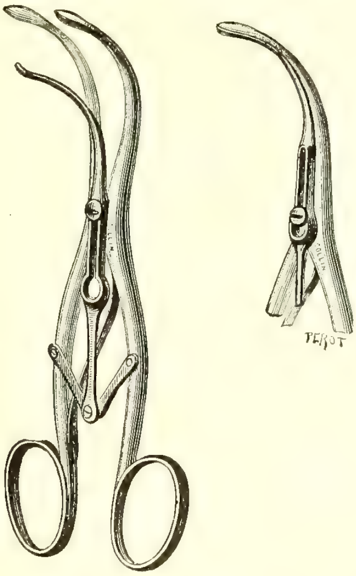
Should all these methods fail, search must be made for the body. For this purpose it is customary to have the edges of the wound held apart by a special dilator—the two-bladed instrument of Trousseau (Fig. 1040), or the three-bladed one of Laborde (Fig. 1041), being held in position by an assistant. Dress-hooks, or other bent hooks, attached to a tape or an elastic band, to go round the neck, will answer the purpose. The automatic retractor

Fig. 1040.



Trousseau's dilator.

Fig. 1041.



Laborde's dilator.

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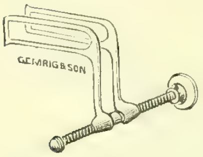
[1] According to Guyon (loc. cit.), first formally proposed in 1644, by Monavius, and first practised in the presence of Verduc (Pathol. de Chir., tome. ii. p. 849. Paris, 1710).

of Golding Bird[1] (Fig. 1042) is the best instrument that I have used or seen used for the purpose. When respiration is improved by the operation, the presumption follows that the foreign body is in the larynx, and that organ therefore should be explored first. The foreign substance can sometimes be pushed into the mouth by means of the exploring instrument. Annandale[2] recommends additional support from the mouth by introduction of the finger. Exploring and extracting instruments should be warmed before they are introduced into the air-passage, so as to diminish their liability to excite spasm; should this occur, the instrument should be maintained in position without using any force, for the spasm usually ceases in a few moments.

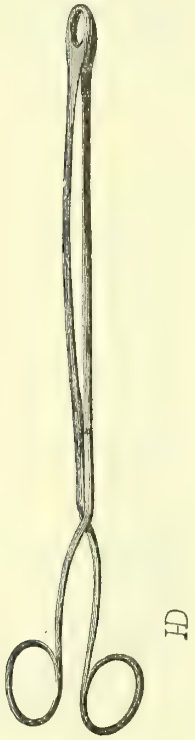
Fig. 1042.



Golding-Bird's retractor.

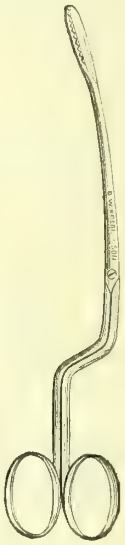
The instrument employed will vary with the character and position of the foreign body, and with the resources of the surgeon. A long probe, bent at one end into a blunt hook, and a delicate pair of forceps, are perhaps the most useful instruments. Gross's flexible, German-silver tracheal forceps (Fig.

Fig. 1043.



Gross's tracheal forceps.

Fig. 1044.



Cohen's tracheal forceps.

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[1] Lancet, March 1, 1881, p. 407 (illustrated).

[2] Med. Times and Gaz., Feb. 27, 1875.

1043) are highly commended by most surgeons. A pair of shouldered forceps used by myself (Fig. 1044)—a combination of Gross's nasal polypus-forceps and Simrock's nasal dressing-forceps—seems to me both stronger and easier of manipulation. The instrument is first used as a sound to detect the foreign substance, and then the effort is made to seize it or dislodge it, as may be. For substances—such as nut-kernels, for example—impacted in a bronchus, a stout copper wire, bent into a short blunt hook, serves an admirable purpose. The forefinger is often available as a searcher or guide to instruments. The bifurcation of the trachea can usually be reached with it.[1]

Efforts at extraction should not be too prolonged. It is better to keep the wound patent—by dilators, hooks, or stitches—and to repeat the efforts on the day following. A canula would be out of place if the foreign substance were below the wound, as it would impede the spontaneous expulsion which often follows the practice here recommended. Spontaneous expulsion after tracheotomy is often delayed until the inflammatory sequelæ have subsided. Thus, a pin-point dart was expelled from a bronchus sixteen days after the operation.[2] In removing substances from a bronchus, after tracheotomy, Annandale[3] recommends a deep inspiration, and temporary occlusion of the wound until the deep expiration follows—a movement which often drives the body out. Many ingenious devices have been employed to meet special indications. Thus, in the removal of tracheotomy tubes, a wire is used, the end of which has been bent into a blunt hook to catch the edge of the tube. Davy[4] placed a patient's head slightly lower than his heels, threaded the eye of a surgical probe for safety, hooked the probe at the other end and caught it on the edge of the outer tube, and thus extracted both tubes, which had been telescoped in the trachea to the extent of 3⅝ inches. A pen-case was in the left bronchus; tracheotomy had been performed; Laidler[5] passed a silver plummet, fifteen inches long, by the side of the foreign body, and moved it up and down, much after the manner of priming a pump. By this plan, aided by voluntary cough, the body was eventually coaxed to the orifice and extracted with forceps.

In cool weather, the air of the apartment occupied by the patient should be kept artificially warmed to about 70° F., and should be moistened by evaporation of hot water as long as the artificial opening is kept patulous. When it becomes desirable to close the wound, it is merely necessary to retain its cutaneous edges in apposition with adhesive strips.

Ordinary pharyngotomy has been performed by Wheeler[6] to remove a needle impacted in an arytenoid cartilage, and sub-hyoidean pharyngotomy has been performed by Lefferts[7] to remove a watch-ring imbedded in the aryteno-epiglottic fold and the ventricular band. Both these procedures, however, are unusual in the management of foreign bodies in the air-passages.

FISTULA OF THE LARYNX AND TRACHEA.

Fistulæ of the larynx and of the trachea occur as congenital defects, and as pathological perforations. The surgical laryngotomy or tracheotomy wound is a fistula likewise, but, being made on purpose, does not come into discussion here.

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[1] Sands, cited by Buck (Trans. New York Academy of Medicine, 1870).

[2] Conner, Am. Jour. Med. Sci., October, 1877, p. 595.

[3] Med. Times and Gaz., Feb. 27, 1875.

[4] Brit. Med. Jour., July 8, 1876.

[5] Brit. Med. Jour., October 27, 1877, p. 590.

[6] Medical Press and Circular, April 22, 1875.

[7] Medical Record, Dec. 15, 1874.

Congenital fistula may be complete or incomplete. It is attributed[1] to defect in the normal closure, during fœtal existence, of the third or fourth branchial fissure, or to defect in the union of the third or fourth branchial arch. In the former and more frequent instance, the external orifice, for the lesion is usually unilateral, will be located at the inner border of the sterno-mastoid muscle, or between its two heads, half an inch or more above the sterno-clavicular articulation. In the latter instance, the orifice is in the middle line, sometimes as high up as the cricoid cartilage. When the lesion is bilateral, in the first class of cases, the two integumentary orifices are usually symmetrically located. Ten instances of bilateral fistula out of a total of forty-six have been collated by Heusinger.[2] One instance has been reported of three external orifices arranged longitudinally.[3]

The integumentary opening is usually quite small, barely permeable with a lachrymal probe, sometimes admitting a bristle merely. The orifice is bulbous, often tumid, sometimes indurated, and usually congested. It becomes temporarily sealed from time to time by desiccated mucus. The fistulous track is very minute in calibre, often impassable by the most delicate probe. It is lined with mucous membrane, sometimes quite discernible at the external orifice, from which a drop or two of mucus or muco-pus exudes from time to time, or is pressed out by the patient at intervals for purposes of cleanliness. The internal orifice opens into the larynx much more frequently than into the trachea. Tracheal fistulæ, for some indeterminate cause, have been noted almost solely in females.[4] In incomplete fistula, there will be no integumentary opening unless an abscess is formed, the discharge of which, externally, converts the lesion into a complete fistula. Hence the history of a complete fistula usually begins with birth, or shortly thereafter, while the history of an incomplete fistula begins much later in life, dating from the appearance or rupture of the overlying abscess. Thus a case was observed in Langenbeck's clinic,[5] of a child twelve years of age, in whom a tumor, probably an abscess, some two inches above the sternum, and in the median cervical region, had been opened with caustic several years previously; and a somewhat similar case, in a lady in her thirty-seventh year, has occurred in the practice of Dr. Young, of Florence, and Mr. Pugin Thornton,[6] of London, the internal orifice, which was detected laryngoscopically, occupying the right ventricular band—a location indicative of an intricately circuitous track, probably due to abscess in two directions.

Symptoms.—The symptoms are a daily discharge of two or three drops of mucus or purulent mucus, from a minute pouting orifice in one of the localities mentioned; the expulsion of air-bubbles on forced expiration, in some instances; and the ability to draw air inward in exceptional cases. Abnormal voice has occasionally been noted. In a few examples of supposed incomplete fistula seen by myself,[7] in young adults of both sexes, sudden emphysematous tumefaction occurred from time to time in the anterior cervical region, the tissues in one instance becoming pushed beyond the chin. At times, all this would occur within a few minutes; at times it would consume several hours. Though most frequent after exertion, or under emotional influences, sobbing, etc., the phenomenon was said to occur at other times without any appreciable exciting cause.

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[1] Foerster, Die Missbildungen der Menschen. Jena, 1861.

[2] Virchow's Archiv, Bd. xxxiii. S. 177.

[3] Ascherson, De fistulis colli congenitis. Berlin, 1832; cited by Riegel and by Agnew.

[4] Bardeleben, Lehrbuch der Chirurgie und Operationslehre, Vierte Ausgabe, Bd. iii. S. 445. 1864; cited by Riegel.

[5] Fischer, Pitha und Billroth's Handbuch, Bd. iii. Abth. i. Lief iii.; cited by Riegel.

[6] Archives of Laryngology, April, 1883, p. 127 (with laryngoscopic illustration of laryngeal orifice).

[7] Op. cit., p. 598.

Diagnosis.—Occasionally, it is said, the internal orifice can be detected laryngoscopically, but the only exemplification at my immediate command is the case of Young and Thornton, above alluded to. When not so discernible without other aid, the opening can be detected, it is said, after the passage of a bright silver probe through the track, or after the injection of a colored liquid. Only exceptionally, however, can a probe be insinuated into the trachea. Of all the cases cited by Dzondi,[1] all of which, it may be mentioned, occurred in females, in one only had the probe been passed without doubt into the trachea. The expulsion of air-bubbles, on voluntary effort with nose and mouth closed,[2] is exceptionally an additional factor in diagnosis. The frequent absence of this physical sign allows the case to be confounded with one of pharyngeal fistula.

Prognosis.—The cure of a congenital fistula is always doubtful. Thornton cured his patient by electrolysis.

Treatment.—The methods employed comprise irritant injections with solutions of iodine, carbolic acid, nitric acid, and acid nitrate of mercury; cauterization with a probe dipped into nitric acid; cauterization with the galvanocaustic point, or with a red-hot copper wire passed through a small canula previously slidden through, over a probe; electrolysis; and excision of the fistulous track. In a case of congenital fistula of the larynx, in a young gentleman upon whom I performed the latter operation, a fresh fistulous track formed subsequently, and opened in an adjoining spot; but it yielded much less secretion than the original one.

PATHOLOGICAL FISTULÆ are laryngeal much oftener than tracheal. They occur as the result of incompletely healed abscesses, and of incompletely cicatrized wounds and perforations. The abscesses follow perichondritis and chondritis, terminating in caries and necrosis, whether from typhosis, tuberculosis,[3] syphilis,[4] lupus,[5] morbid growth,[6] foreign body in the air-passage or œsophagus, or external compression by an enlarged gland or morbid growth. The wounds are usually suicidal, sometimes homicidal, sometimes accidental, and occasionally surgical. Fistulæ after suicidal wounds are not infrequently due to interference with the dressings by the patient's own hands. Perichondritis, chondritis, caries and necrosis, sometimes form the pathological sequence, as in fistula from disease.

Connective tissue hyperplasias often occur in the softer tissues, and thus stricture of the larynx may coexist.

When resulting from intra-laryngeal neoplasm, the fistula usually occupies the cricothyroid membrane, which undergoes absorption in some instances, and ulcerative perforation in others. When the result of a wound, it is due to incomplete closure, as in suicidal incised wounds, or to extensive ulceration and necrosis, as in gunshot wounds. Under these circumstances, the orifice is sometimes very large, as in the case mentioned on page 639, and it is very irregular in outline. Occasionally, a tracheal fistula remains from incomplete closure of a tracheotomy wound.[1]

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[1] De fistulis tracheæ congenitis. Halæ, 1829; cited by Riegel.

[2] Ammon, Die angeborenen chirurgischen Krankheiten der Menschen. Berlin, 1842; cited by Riegel.

[3] Krieg, Wiener medizinische Zeitung, 1880; cited by R. de la Sota (Rev. Méd. de Sevilla, tomo iii. No. 33. 1883.)

[4] Lefferts, Archives of Laryngology, Jan. 1883, p. 53; R. de la Sota, loc. cit. (From a suppurating gumma in the infra-hyoid region.)

[5] E. H. Bennett, Brit. Med. Jour., Feb. 25, 1882, p. 273; continued in Dub. Jour. Med. Sci., July, 1882, p. 81; and private confirmatory note, Nov. 10, 1882.

[6] R. de la Sota (Archives of Medicine, April, 1884, No. 2) reports a case originating in a prethyroidal cyst.

Symptoms.—The symptoms are escape of air, saliva, mucus, pus, and *débris* from the external orifice. Decomposition of the discharges takes place in consequence of their free exposure to the atmosphere, and the stench becomes horribly fetid in some instances. The voice is considerably altered, and not at all audible in a fissure of any size below the vocal bands, unless the orifice be occluded with the finger or with a compress. Cough is harassing. Dysphagia exists in some instances. Emaciation is sometimes extreme. Symptoms of septic poisoning become superadded in some cases, especially in those which are about to terminate fatally.

Diagnosis.—The external communication with the interior of the air-passage is so obvious on inspection that a mistake in diagnosis is hardly possible. Sometimes the internal orifice can be detected laryngoscopically, even when quite minute, especially when a probe can be passed through the track, as in R. de la Sota's case, above referred to.

Prognosis.—The probability of successful obliteration is dependent upon the nature of the disease or injury by which the fistula has been produced, the size of the orifice in the air-tube, and the preservation of sufficient surrounding integument to admit of its closure by adhesive inflammation or by plastic operation. In Bennett's case, due to ulceration by lupus, the fistula closed completely under the inflammatory process excited by an intercurrent erysipelas, which commenced at the fistula, and extended over the neck, face, and upper part of the body. A large fistula cannot be cured, but the orifice may be occluded with a compress when the patient wishes to talk, and may be kept hidden from sight by some simple apparatus worn around the neck. Life may be prolonged for years under such conditions, as in a case of tracheal fistula known to Van Swieten, and reported by Boyet,[2] and in the case of laryngeal fistula mentioned on page 639.

Treatment.—In small fistulæ, the borders of which are covered by integument, it has been recommended by Dieffenbach,[3] to touch the edges with tincture of cantharides, and then draw them together by sutures, which are allowed to remain for six or eight days. When the interior of the trachea is exposed, the same surgeon excises a small wedge of integument above and below, detaching the edges sufficiently to secure apposition without tension, and then inserts four or more points of twisted suture. If the edges are indurated, he makes a long vertical incision on each side, and detaches the flaps from the subjacent tissues. Watson[4] recommends removing a circular section of integument from the circumference of the opening, and uniting the wound with twisted sutures. Le Fort[5] in one case freshened the edges of the orifice, applied semi-elliptic flaps of integument, taken from above and below, and secured them with stitches, which were removed on the sixth day. A small opening, which remained from the giving way of the middle stitch, yielded to cauterizations with nitrate of silver.

In a large fistula from suicidal wound, a friend succeeded in closing the gap, at my suggestion, by adjusting a flap, cutaneous side inward, cutting the exuberant portion loose after adhesion had taken place, and replacing it upon the proximal portion of the gap in the integument—the distal portion having been united by twisted suture at the initial operation. It is a matter of regret that my notebooks fail to trace this device to its originator.

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[1] For a case reported after laryngotomy for diphtheria, see Dupuis, Deutsche Zeitschrift für Chirurgie, 25 Marz, 1875; Lefferts's Reports, New York Med. Jour., July, 1875, p. 84.

[2] Cited by Cruveilhier (Traité d'Anatomie Pathologique, t. ii. p. 560. Paris, 1852).

[3] Die operative Chirurgie, Bd. i. S. 508.

[4] Edinburgh Med. Jour., April, 1844.

[5] Dictionnaire de Médecine et de Chirurgie Pratiques. Article Larynx, p. 287. Paris, 1875.

Lefferts[1] succeeded in closing a syphilitic fistula of the larynx by performing a tracheotomy for coexisting stenosis in such a manner so as to include the fistulous opening, scraping the edges clean, treating the disease which produced the lesion, and then removing the canula.

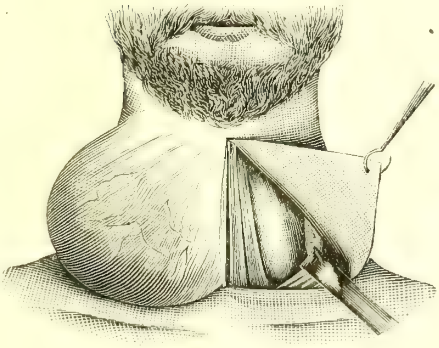
Agnew,[2] in a case remaining after suicidal wound, cut a long rectangular flap of skin, turned it upon itself so as to be able to adapt the distal raw surface to the freshened edges of the gap, and thus plugged the orifice.

Large fistulæ do not appear to be amenable to obliterative treatment. They are to be covered with compresses or pads, concealed beneath the collar and neck-cloth.

Stricture of the Larynx and Trachea.

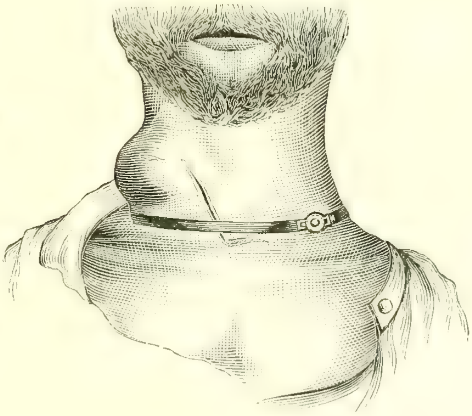
Stricture of the larynx and trachea, technically known as stenosis, is either extrinsic or intrinsic. Sometimes the two conditions coexist.[3] One organ or both may be implicated; and there may be more than one point of constriction, whether in the larynx or in the trachea. Extrinsic stricture is due to involution of the walls by pressure outside of the aërial canal—*compression-stenosis*—whether produced by foreign body, by localized emphysema, by cervical abscess, by enlarged thyroid, thymus, or cervical or bronchial lymphatic glands, by cicatricial tissue, by morbid growth—cervical, œsophageal, or mediastinal—by aneurism, or by disease of the vertebræ, sternum, or clavicle. In cases of cervical tumor or abscess, the trachea may be pushed far out of line, as in a remarkable case, as yet unpublished (Figs. 1045 and 1046), under the care of Dr. Janney, of Philadelphia.

Fig. 1045.



Compression and deflection of trachea by cervical tumor; sterno-mastoid retracted to show trachea 2⅛ inches to left of median line, and 2¼ inches below integument. (Janney.)

Fig. 1046.



Canula in position three months after operation; recession of tumor and trachea towards median line. (Janney.)

Intrinsic stricture—*occlusion-stenosis*—is due to congenital malformation or disease,[1] to foreign body or neoplasm within the canal, or to disease in its walls, to paralysis of the dilating muscles of the larynx, to spasm of its constricting muscles, or even to spasm of the trachea.[2] Intrinsic stricture may be due to temporary causes, such as inflammatory tumefaction, hemorrhagic effusion, œdema, pseudomembrane, benignant neoplasm, foreign body, spasm, and paralysis; or it may be due to permanent causes, such as intussusception of the trachea,[3] longitudinal involution,[4] hypertrophic or hyperplastic tumefaction, neoplasms clinically or histologically malignant, granulation neoplasms,[5] organized membrane, inflammatory adhesions between adjacent structures[6]—such as vocal bands, ventricular bands, arytenoid cartilages, epiglottis, and pharynx—or cicatricial contraction following ulcerative processes, whether originally syphilitic or tuberculous, traumatic, the results of scalds and cauterizations,[7] or occurring in smallpox, measles,[8] scarlatina, diphtheria,[9] or enteric fever.[10] In cases of suicidal wound, the larynx may become occluded by a cutaneo-pharyngeal membranous partition.[11]

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[1] Loc. cit., p. 56.

[2] Med. and Surg. Rep., April, 1873, p. 316.

[3] For example, see Ashhurst's case of Fistula. Med. and Surg. Rep., August 14, 1880, p. 142.

The extent to which the calibre of the trachea is diminished in extrinsic stricture, varies between extreme limits. When the pressure is great, it may become reduced to a mere slit-like passage, the direction of which, determined by the direction of the compression, although most frequently transverse, may even be antero-posterior.[12] As a rule, the only pathological condition noted has been the involution of the tract, without structural change. Hypertrophy of the mucous glands and submucous connective tissue has frequently been found, however, in cases of compression by goitre,[13] and perhaps under other similar conditions. Ossification of the laryngeal cartilages and extensive amyloid and calcareous degeneration of the tracheal walls have been noted occasionally,[14] while attenuation and atrophy of the cartilaginous rings are not uncommon, and even complete absorption may take place, so that the tube becomes perforated.

In intrinsic stricture, the amount of constriction varies between the extremest limits imaginable. Complete obliteration of the canal takes place in some instances, life being saved by tracheotomy below the seat of stricture. The tightest intra-laryngeal strictures are observed chiefly in cases of syphilis, and in cases of wounds, suicidal and gunshot. The most frequent cause in America is local syphilitic disease, and the next, suicidal wound; but enteric fever[1] seems to be the most frequent cause on the continent of Europe. After suicidal wound, although the vocal bands may remain intact, the lower portion of the larynx may undergo complete funnel-shaped obliteration.[2] The tightest intra-tracheal strictures are produced by cicatrization of syphilitic ulcerations. Thus, in a case reported by Worthington,[3] the calibre of the tube had become reduced to that of a crow-quill. In this case the cartilaginous rings below the seat of constriction, at the upper rings of the trachea, had undergone attenuation and dilatation, quite from the point of bifurcation. Intra-tracheal cicatricial stricture is most frequent just above the bifurcation, but it occurs at a higher level, as at the fourth and fifth rings,[4] and not infrequently just below the cricoid cartilage.[5] The depth of the stricture varies from a few lines to more than an inch.[6] Gerhardt mentions four cases[7] in which the entire surface of the tracheal wall was the seat of disease.

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[1] Elsberg, Trans. International Medical Congress, vol. iii. London, 1881; DeBlois, Cases of congenital membranous web, New York Medical Journal, 1884; Steavenson, Case of cyst in crico-thyroid membrane, St. Bartholomew's Hospital Reports, vol. xviii. p. 330.

[2] Allison, On Morbid Throat in Relation to Consumption, p. 12. London, 1869; Schnitzler, Wiener Klinik., Jan. 1877.

[3] Lee, Med. Times and Gaz., May, 1874, p. 548. (In this case the posterior portion of the upper tracheal ring approximated the cricoid cartilage to within one-quarter of an inch.) Long, Memorabilien, 11 Jan. 1876. (In this case it was found, after death, that the third tracheal ring was forced inside the second when the head was flexed.)

[4] Carrié, Thèse. (In this case, in which sudden death, on removal of the canula, had been attributed to granulation neoplasm, there was found longitudinal involution, the result of approximation of the posterior extremities of the severed cartilages.)

[5] Bouchut, Gaz. des Hôp., No. 35. 1874. (A fatal case after tracheotomy.)

[6] This occurs sometimes after tracheotomy. Mackenzie, Am. Jour. Med. Sci., April, 1870, p. 487.

[7] Stenosis of Larynx from Sulphuric Acid. Fieber, Allg. Wien. med. Ztg., No. 8, 1874.

[8] G. Hunter Mackenzie, Edinb. Med. Jour., Oct. 1883; Med. and Surg. Rep., Oct. 27, 1883, p. 471. (Stenosis of Larynx.)

[9] Complete laryngeal stenosis has been observed by Stoerk.

[10] Kiessebach has reported a case with stenosis of both larynx and trachea. Deutsch Ztg. f. Chir., Bd. xiii. S. 554.

[11] Reynaud, Journ. Univ. et Hebd., tome iii. p. 201. 1831; Bourgot, Thèse de Montpellier, 1844.

[12] Balser, Virchow's Archiv, Bd. xci. H. 1.

[13] Demme, Wurzburg med. Ztschrift, Bde. ii. und iii. 1861; cited by Riegel.

[14] Balser, loc. cit.

Symptoms.—The symptoms, though varying somewhat in detail, are similar, no matter where the constriction. The main symptom is inspiratory dyspnœa, whether constant or only developed on exertion. As the stenosis becomes greater, the dyspnœa increases, and the voluntary muscles of respiration are brought prominently into play. The inspiratory stridor gradually augments, in some instances merging into stridulous respiration in both phases, with recession of the soft parts during inspiration. The face becomes pale or livid in severe cases, the countenance expresses anxiety or dread, and the pulse becomes small and frequent. Sensations of oppression of the chest become a source of discomfort and of fear. Cough is not a necessary phenomenon, and presents itself independently of the stricture. Compression of a primitive bronchus, and especially of both bronchi, will produce symptoms identical with those of compression of the trachea. Certainty of differential diagnosis, then, depends upon recognition of the bifurcation in the laryngoscopic image. The symptoms are usually gradual when due to disease other than acute laryngitis; and they often present themselves suddenly when due to injury.

The usual phenomena of suffocative apnœa supervene, should the constriction become extreme. The voice is impaired in the majority of cases; but the character of the impairment depends upon the location of the constriction. It is faint and muffled in many cases of tracheal stricture, owing to the small amount of air passing. Deglutition may be impeded when the upper part of the larynx is involved.

Diagnosis.—The history of the case, the dyspnœa, and the stridulous respiration, are sufficiently indicative of the character of the lesion. Marked vertical movement of the larynx in respiration has been thought to indicate obstruction in that organ; and slight movement, or want of it, to indicate obstruction in the trachea;[8] but this sign is by no means thoroughly reliable for such discriminative diagnosis. Auscultation of the larynx and trachea furnishes little information as to the seat of the lesion, the sounds being too confused for due interpretation.

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[1] Lüning, Die Laryngo- und Tracheo-stenosen im Verlaufe des Abdominaltyphus, und ihre chirurgische Behandlung. Arch. f. klin Chir., Bd. xxx. H. 2, S. 225–340, und H. 3, S. 523–619; abstract in Internationales Centralblatt für Laryngologie, u. s. w. Aug. 1884, S. 72.

[2] Küchler, Deutsche Klinik, 1 Mai, 1869, S. 169. (The patient in this case died five years after the wound, from typhoid fever.)

[3] Med.-Chir. Trans., vol. xxv. p. 230. London, 1842.

[4] Thornton, Med. Times and Gazette, June 27, 1874, p. 704.

[5] Worthington, loc. cit.; Hall, Brit. Med. Jour., April 26, 1884, p. 814; Bayer, Rev. Mens. de Laryngologie, etc., Juin, 1884, p. 95; Ashhurst, Med. and Surg. Reporter, 1880.

[6] Stoerk, Klinik der Krankheiten des Kehlkopfes, des Nase, und des Rachens, S. 436. Stuttgart, 1880. (In this case a conical canula reached clear into the right bronchus); Mackenzie, op cit., p. 537.

[7] Cited by Riegel, loc. cit., p. 483.

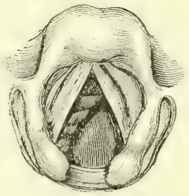
[8] Gerhardt, Lehrbuch der Auscultation und Percussion, S. 219. Tübingen, 1871.

Impairment of the vesicular respiratory murmur is perhaps a constant phenomenon; its extinction is indicative of great occlusion of the canal. According to Gerhardt, the head is apt to be held backward in laryngeal constriction, and slightly depressed, with extended neck, in tracheal constriction.

Rapidly progressing symptoms, developing within a few days or a few hours, are indicative of intrinsic stenosis of a temporary character. Slowly progressive symptoms, occupying weeks, months, or years, are indicative of permanent constriction, whether by compression or by occlusion. Symptoms developing during croup, diphtheria, measles, and scarlatina, are usually indicative of obstruction by pseudo-membrane, but may be due to paralysis of the dilating muscles of the glottis, or to spasm. Symptoms developing during enteric fever are indicative of laryngeal perichondritis. Evidence of syphilis indicates gumma, or cicatricial constriction.

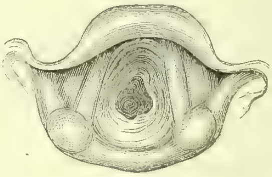
Laryngoscopic or laryngo-tracheoscopic inspection is necessary to determine the seat and character of the lesion. The picture of stricture of the glottis caused by adhesion of the two arytenoid cartilages, is so much like that of paralysis of the posterior crico-arytenoid muscles, that the two conditions are liable to be confounded. Tuerck[1] has described and illustrated the laryngoscopic image in several cases of compression-stenosis of the trachea, by tumors external to the tube. Compression-stenosis from involution of the trachea by aneurism of the arch of the aorta (Fig. 1047) and from acute bronchocele, has been recognized laryngoscopically by myself,[2] and similar stenosis due to mediastinal tumor has been recognized in the same manner by Pastau[3] and by Riegel.[4] An admirable illustration of concentric stricture of the trachea (Fig. 1048) has been given by Mackenzie.[5] Tracheal stricture, however, can by no means be always thus detected; but the positive absence of laryngeal obstruction, and lack of sufficient evidence of sources of compression externally, strongly support the inference of intrinsic tracheal stricture. Instrumental exploration is sometimes the sole means of determining the presence of intratracheal stricture; but the manipulation is not always feasible.

Fig. 1047.



Involution of trachea by aneurism of the arch of the aorta. Extreme inspiratory dyspnœa.

Fig. 1048.



Concentric constriction of the trachea. (Mackenzie.)

Laryngoscopically, carcinoma of the larynx in its early stages cannot be discriminated from chronic inflammatory tumefaction of the mucous membrane, or of the perichondrium. Any swelling existing externally, however, would be likely to be diffuse and painful if due to carcinoma, and circumscribed and painful if due to perichondritis.

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[1] Op. cit., S. 507 u. folg.

[2] Op. cit., p. 595.

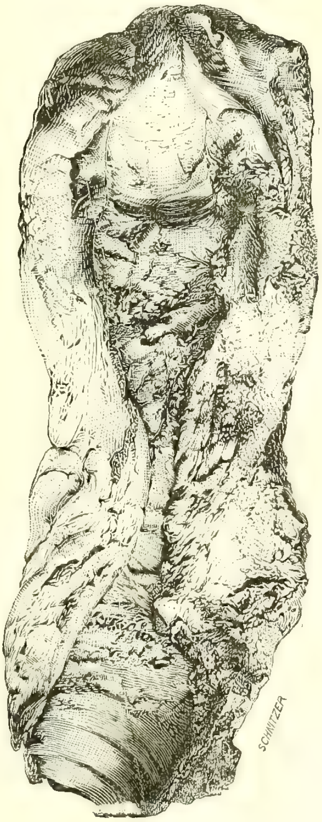
[3] Virchow's Archiv, Bd. xxxiv. S. 236.

[4] Ibid., Bd. xlix. H. 2, S. 193.

[5] Op. cit., p. 536.

The importance of laryngoscopic inspection is not to be underrated; without it, the risk is run of making a useless incision above the point of constriction, as has been done more than once.[1] Even when the larynx is seen to be the seat of constriction, extensive stricture of the trachea may remain unrevealed, as in a case of unavailing tracheotomy graphically described by Mr. Thornton.[2] (Fig. 1049.) When the air-tube has become perforated externally from destruction of cartilage, or from any other cause, digital or instrumental palpation can be employed to detect the seat and character of the stenosis. The same manipulation is applicable after surgical incisions into the passage. Compression-stenosis from intra-thoracic tumor is diagnosticated chiefly by auscultation and percussion of the thorax. Cough, dyspnœa, and aphonia, are additional symptoms, observed usually as the result of pressure upon the inferior laryngeal nerve. In some instances the dyspnœa is manifested wholly, or in greater measure, in the expiratory phase of respiration, under which circumstance the phenomena may be incorrectly regarded as entirely asthmatic.

Fig. 1049.



Syphilitic cicatricial narrowing of trachea. Ulceration extended from vocal cords to lower end of stricture. (After Thornton.)

Prognosis.—In extrinsic stricture, the prognosis depends entirely upon the prospect of relieving or curing the condition which causes the involution of the wall of the air-tube. It is unfavorable, therefore, in cases of aneurism of the aorta, tumors of the mediastinum, irremediable hypertrophic disease of the thyroid gland, and cervical tumors insusceptible of extirpation. Long-continued compression may produce anæmia, and collapse of the lung with hydrothorax.[3]

Even though the stricture be beyond relief, the higher up the point of compression, the better is the prognosis as to life whenever tracheotomy is practicable below the obstruction.

Intrinsic stricture due to benign neoplasm is remediable by extirpation of the growth; and the higher up it is located, the greater the opportunity for removal under laryngoscopy, and the better, therefore, the prognosis. The same remark is applicable to stenosis from a foreign body. When beyond the reach of manipulation through the mouth, the question of a necessary laryngotomy or tracheotomy adds a proportionate gravity to the prognosis, which, however, remains good if the operation be not delayed. In very favorable cases, laryngeal stricture may be overcome by systematic dilatation, so that the canula can be permanently withdrawn from the artificial opening. Its continuous retention is requisite, however, in most cases—in America at least—the tendency to reproduction of the stricture being usually insurmountable. Tracheal stricture presents an unfavorable prognosis in all instances in which the obstruction is beyond the point at which tracheotomy can be made available, tracheal stricture being hardly ever susceptible of dilatation. When sufficiently high up to permit a tracheotomy, the prognosis as to life is favorable should the operation be successful. When irremediable by operation, death usually occurs gradually by coma. Sometimes it is sudden, by occlusion of the constricted passage with blood, pus, or mucus.

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[1] Dict. de Méd. et de Chir. Prat., t. xx. p. 293. Art. Larynx. Paris, 1875.
[2] Op. cit., p. 34.
[3] Moore, Dub. Jour. Med. Sci., November, 1876, p. 433.

Treatment.—In compression-stenosis, the treatment is necessarily purely symptomatic in many instances, the cure of the stenosis being entirely dependent upon cure of the disease by which it has been caused. Thus a foreign body is to be withdrawn from the œsophagus, an enlarged thyroid gland to be reduced in volume, released from tension, or extirpated, as may be indicated, and so on through the group of lesions which may produce the compression. Relief to the dyspnœa can be afforded by tracheotomy, provided that the opening can be made below the point of compression.

Occlusion-stenosis from causes of temporary character, such as spasm, inflammatory tumefaction, œdema, hemorrhagic effusion, pseudo-membrane, foreign body, and neoplasm, requires the treatment proper to those conditions.

Should suffocative apnœa be threatened, prophylactic tracheotomy becomes indicated, whether the stenosis be temporary or permanent in character; but the operation may fail to afford relief, should the strictured portion of the canal be so far below the artificial opening as to be beyond the reach of a tube.

Stricture of permanent character requires an artificial opening into the passage below the seat of stricture, as an initial procedure. In the majority of instances, a canula has to be worn during the remainder of the patient's life; but much can be done in some cases, especially those of laryngeal stricture, towards restoring the normal calibre of the passage, so that the canula may be definitively removed. In exceptional instances, dilatation can be effected without previous tracheotomy; but there is considerable doubt whether the necessary manipulations are justifiable except in cases of very moderate occlusion of the canal.

Laryngoscopy has given great impetus to treatment by dilatation. Desault, as far back as 1793, while favoring catheterization of the air-passage in tracheal stenosis, if due to compression by tumor or by foreign body in the œsophagus, as well as in stricture due to wound, on the whole preferred tracheotomy. More than half a century later, and just about the time that laryngoscopy was attracting professional attention, this plan was revived by Bouchet, under the term "tubage" of the glottis,[1] chiefly in connection with occlusion from acute inflammatory processes; but the manipulation was not well borne by the parts, and tracheotomy had to be performed in every instance.

When adhesions exist between vocal bands, ventricular bands, or arytenoid cartilages, they should be divided with the knife or the galvano-cautery, before dilatation is attempted. Re-adhesions are frequent after both procedures. These operations are usually performed through the mouth. In a case of extensive adhesions between the vocal bands, Dr. Eysell,[2] of Halle, passed a tenotome through the cicatrix, and guided its subsequent movements by laryngoscopic reflection. The galvano-cautery, usually considered a safe instrument, is not invariably safe. In one case in which it was employed to divide an adhesion between the epiglottis and the pharynx, hemorrhage ensued to such an extent as to require ligation of the external carotid artery.[1]

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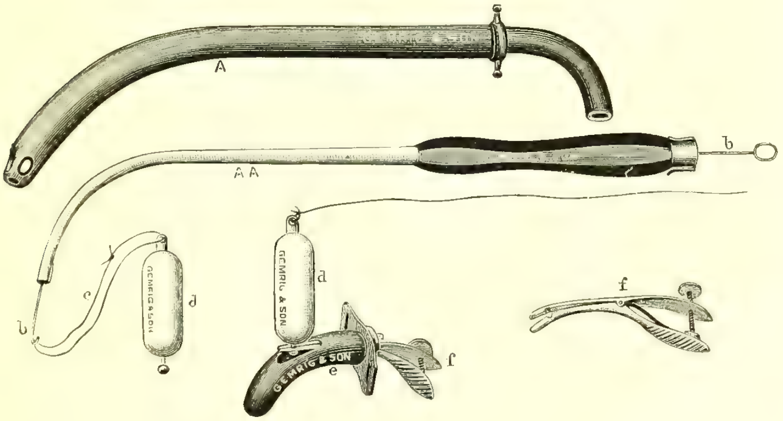
[1] Bulletin de l'Académie de Médecine, t. xxiii. 1858.

[2] Med. Times and Gaz., Oct. 17, 1874; Am. Jour. Med. Sci., June, 1875, p. 275.

In occasional instances, the stenosis seems amenable to dilatation of the simplest character. Thus Asch[2] cured a case by dilatation with sounds of flexible metal. In some cases, indeed, mere utilization of the dilating power of a stream of air through a fenestrated canula has been found sufficient for the purpose.[3]

Methodized dilatation, persistently practised, has produced remarkable results in the hands of Schroetter, of Vienna;[4] and the plan pursued by him is universally acknowledged to be the most effective. Before describing this method, allusion must be made to a successful result by Liston,[5] in a case after suicidal wound of the crico-thyroid membrane, in which he began with bougies no larger than a darning needle, and finished by inserting a canula equal in diameter to the largest œsophageal tube, which was retained in position for fifteen days. To lessen the salivation excited by dilating tubes, retained in position for hours or days, Trendelenburg[6] employs small segments of dilators intended to occupy the larynx only, a strong and firmly attached thread alone protruding from the mouth. The thread excites less salivation, and conducts much less saliva into the larynx. It is on this principle that Schroetter has based his method. He accustoms the parts to the presence of a catheter or bougie for the first few days—a precautionary manipulation which should not be neglected. He then removes the canula daily, and inserts a catheter through the constriction, allowing it to remain

Fig. 1050.



Appliances used by Schroetter in dilating stenosis of the larynx.

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[1] Heinze, Archives of Laryngology, p. 379. 1880.

[2] Archives of Laryngology, p. 62. 1880.

[3] Gerhardt, Arch. f. klin. Med., Bd. xli. 1873.

[4] Laryngologische Mittheilungen, S. 32. Wien, 1875; Beitrag zur Behandlung der Larynxstenosen. Wien, 1876.

[5] Edinburgh Med. and Surg. Jour., vol. xxix. p. 118. 1828.

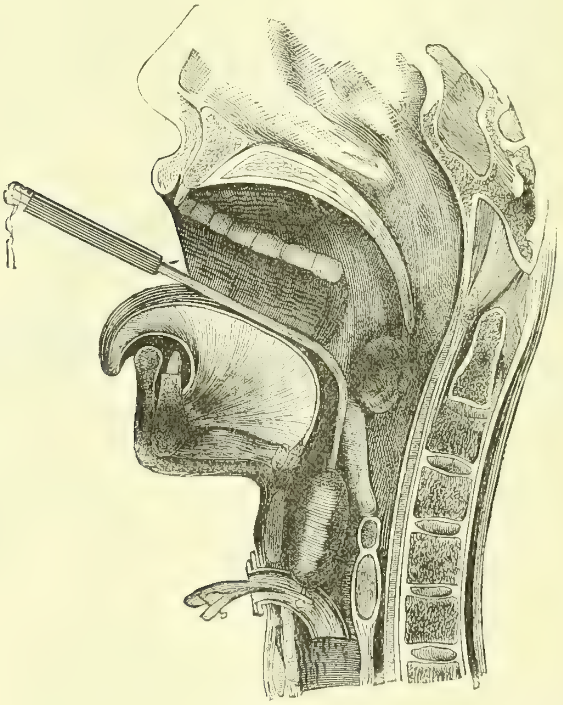
[6] Arch. f. klin. Chir., Bd. xiii. S. 334.

from five minutes to half an hour, as may be. As soon as a No. 15 catheter can be tolerated, he begins with a series of twenty-four special, graduated dilators of smooth, pure tin, shaped to the normal glottis (Fig. 1050 *d*).

These dilators are each four centimetres long, and are graduated in bulk from six to sixteen millimetres. Through each passes a rod, having an eye at the top for affixing a thread, and a knob below, or a perforation by which the bougie can be secured by a pincette (*f*) or by a bolt, passed through the fenestrated canula (*e*) in the artificial opening. The bougie is inserted by means of a canulated director (AA), fitted to a perforation surrounding the eyed rod at top, the thread (*c*) attached to which has previously been drawn through the director by a special wire-hook (*b*), and is then secured at the distal end.

As soon as the bougie has been secured at the lower end, as shown in the diagram (Fig. 1051), the thread is loosened from the director, and that instrument is withdrawn, leaving the bougie in position and the thread hanging from the mouth. The thread being secured, the bougie remains in position day and night, until it becomes necessary to cleanse it, or desirable to replace it with a larger one, when it is released below, and withdrawn by traction on the thread. When the dilatation has been completed, the external wound is closed. Recontraction is prevented by the daily use of curved, hard-rub-

Fig. 1051.



Schroetter's method of dilating stenosis of the larynx. (Labus.)[1]

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[1] Il caterismo e la dilatazione mecanica nelle stenosi della larynge. Milano, 1876.

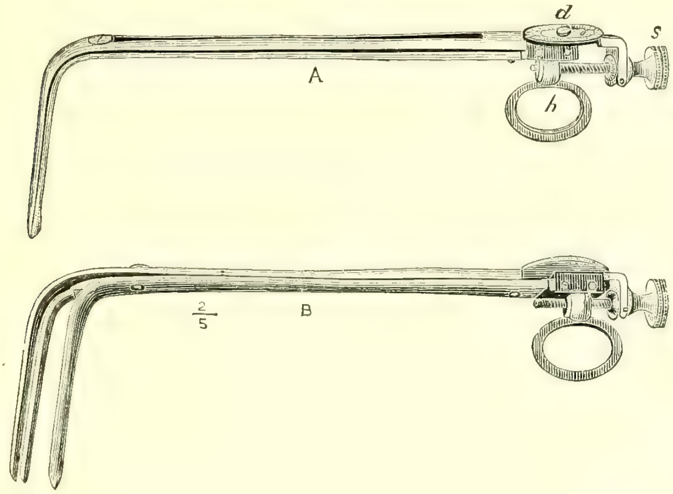
ber tubes, shaped like the bougies at the laryngeal end (Fig. 1050 A), and introduced through the mouth—a curved offset being inserted in the protruding portion, to carry downward the mucus which is coughed out. These tubes are retained in position for from fifteen to thirty minutes. Patients are taught to use them for themselves. The treatment consumes from six to eighteen months in most cases, but occasionally it is much more rapid.

McSherry, of Baltimore, has reported good results in his own hands by Schroetter's method of dilatation,[1] in a case in which the lumen of the larynx had been reduced in size to that of a goose-quill. Weinleichner[2] recommends passing a silk thread from the mouth through the tracheal tube, and knotting it in front, so as to retain it as a permanent guide in placing the sounds or bougies in position. It is said not to interfere with speech or with deglutition, and to need removal only when it becomes soiled. The sound can be borne for from half an hour to three or five hours. A patient upon whom laryngotomy had been performed after typhoid fever, in 1871, was cured of stenosis in this way, and died in 1877, of pulmonary phthisis.

Artificial vocal apparatus has been successfully introduced after dilatation of laryngeal stenosis.[3]

Mechanical dilators, for more rapid work, have been employed by Schroetter, Mackenzie (Fig. 1052), Navratil, and others. These are introduced by the mouth. Stoerk[4] dilates from below with a two-bladed dilator, and McSherry, of Baltimore, with a three-bladed one (Fig. 1053). Rapid dilatation, however, has rarely been successful, and has been found liable to excite inflammation and œdema.

Fig. 1052.



Mackenzie's laryngeal dilator.—*a*, the instrument closed; *b*, the instrument opened; *s*, screw, by which to separate the blades; *d*, dial-plate, indicating the amount of separation; *h*, ring for finger.

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[1] Medical News, May 5, 1883, p. 506; Trans. Med. and Chir. Faculty of Maryland, 1883.

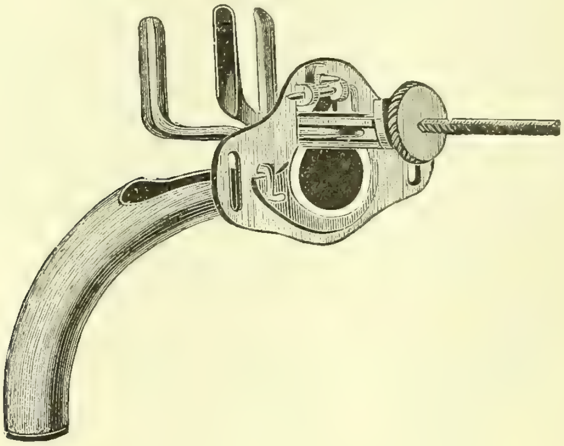
[2] London Medical Record, April 15, 1878, p. 180.

[3] Wegner, Verhandlungen der Deutschen Gesellschaft für Chirurgie, S. 101. 1878; London Med. Record, June 15, 1878, p. 269.

[4] Wien. med. Woch., No. 46, 1879.

Strictures sometimes require external operations to restore the calibre of the canal. Thus in a case of traumatic stricture, after suicidal wound, in which the cricoid cartilage and part of the thyroid were divided to ascertain the cause of the constriction, Mr. Henry Lee[1] found the posterior part of the upper tracheal ring approximated to within a quarter of an inch of the cricoid cartilage. He removed the ring in great part with scissors, and introduced a canula with the inner opening upward, to prevent recontraction. In a somewhat similar case, Prof. Ashhurst, of Philadelphia, dissected off some dense cicatricial tissue, and then removed a portion of the displaced cricoid cartilage with scissors, to overcome a stenosis at the junction of the thyroid and cricoid.[2] Resection of the larynx is sometimes performed,[3] a portion of the anterior cartilaginous wall being removed to afford room for a T-shaped canula, which is retained in position until cicatrization has taken place. Some surgeons deem this procedure preferable to attempts at dilatation.

Fig. 1053.



McSherry's modification of Stoerk's dilator for laryngeal stenosis.

Laryngitis.

Laryngitis, inflammation of the larynx, is the term in general use to designate superficial inflammation of the mucous membrane of the interior of the larynx—*simple or catarrhal laryngitis.* When loss of tissue takes place, as occurs under certain systemic conditions, notably tuberculosis and syphilis, the affection is termed *ulcerative laryngitis. Submucous laryngitis, parenchymatous laryngitis* (Mandl), is a deeper-seated inflammation, involving the submucous connective tissue in addition, and sometimes other tissues also, such as the glands, muscles, and cartilages. Suppurative inflammation of the submucous connective tissue, when diffuse, is described *as phlegmonous laryngitis ;* when circumscribed, as *abscess of the larynx.* Inflammation of the perichondrium is termed *laryngeal perichondritis*, and inflammation of the cartilages *laryngeal chondritis.*

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[1] Med. Times and Gaz., May 16, 1874, p. 548; Trans. Clin. Society, vol. vii., London, 1874; Am. Jour. Med. Sci., July, 1875, p. 175.

[2] Med. and Surg. Rep., Aug. 14, 1880, p. 142.

[3] Reyher, Arch. f. klin. Chir., Bd. xix. S. 334; Heine, ibid., S. 514; Bruns, Berlin. med. Woch., Nos. 38, 39. 1880; Archives of Laryngology, p. 393. 1880.

ACUTE LARYNGITIS.

SIMPLE OR CATARRHAL LARYNGITIS.—This occurs idiopathically, deuteropathically, and traumatically. All these varieties may be associated with tracheitis or bronchitis on the one hand, or with pharyngitis or rhino-pharyngitis on the other. In the former case, the process is usually confined to the interior of the larynx; in the latter, both surfaces are commonly involved. *Acute idiopathic laryngitis* is usually the result of undue exposure to cold or moisture. Among other causes may be cited direct local irritation by mechanical and chemical products, or by over use of the voice; transmitted local irritation in dentition, in stomatitis, and in glossitis; constitutional poisoning, sometimes idiosyncratic, by iodine, antimony, mercury, and other drugs. Occasionally it is rheumatic in origin, and at times associated with synovitis. *Acute deuteropathic laryngitis* occurs in many cases of arthritis, thrush, diphtheria, pneumonia, acute tuberculosis, syphilis, typhus and enteric fever, smallpox, measles, scarlet fever, erysipelas, and pyæmia. *Acute traumatic laryngitis* is the result of local injury, whether through accident, carelessness, or design.[1]

Acute catarrhal laryngitis is usually diffuse. Sometimes it is circumscribed to one or more special structures, such as the epiglottis, a vocal band, or the like, and—when not traumatic—chiefly so in cases of syphilis, carcinoma, tuberculosis, and lupus. The diffuse form may run its entire course to recovery in from twenty-four hours to ten days. The circumscribed variety, when dyscrasic, usually subsides into chronic inflammation of indefinite duration. When traumatic, its duration varies with the character of the injury which has excited the lesion.

The special surgical interest in laryngitis resides in the location of the inflammatory process, rather than in its intensity. The pathological phenomena of congestion, tumefaction, and infiltration, with their sequelæ, are similar to those occurring in inflammation of mucous membranes generally ; but the fact that any considerable swelling in the interior of the larynx, or at its superior outlet, embarrasses respiration by opposing a mechanical barrier to access of air to the lungs in sufficient quantity, renders laryngitis peculiarly menacing to life. Hence every case should be carefully scrutinized from time to time by laryngoscopic inspection, not only to discern the progress of the inflammatory process, but to learn the effect of remedial measures. It will be observed in most instances that the entire laryngeal mucous membrane is congested and swollen. The features of the larynx are much thickened, the tumefaction being symmetrically bilateral as the rule. Movements of the epiglottis may be impeded by the tumefaction of its mucous membrane, so that it is depressed with evident muscular effort, or remains erect. Circumscribed inflammations are recognized by linear, mottled, or diffuse congestions, as may be, and by local tumefactions. Both circumscribed and diffuse congestions and tumefactions vary within extreme limits. Accumulations of mucus, here and there, simulate points of ulceration; for it is sometimes extremely difficult to determine, in the reflected image, whether a given abnormal appearance be sunken or in relief. Mucus, unless very adherent, can usually be detached by cough, and when cough fails, by douching. But ulceration does not occur in simple catarrhal laryngitis, and even erosions are unusual. Paresis of some of the muscles which close the glottis will often be recognized, either by gaping of the entire chink, or by gaping of its inter-arytenoidal extremity. The paresis is due to intermuscular infiltration and not to disease of the nerve tracts. Should the laryngitis be severe, œdema of the larynx (discussed at page 647) may ensue.

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[1] See under Wounds and Scalds (page 628), Fractures (page 655), and Foreign Bodies (page 664).

The *symptoms* are, in mild cases, pain, cough, and impairment of voice, without special pyrexia. In severe cases phenomena of fever are present, and difficulty in deglutition and in respiration may becomed added to the symptoms mentioned, themselves much more aggravated.

The *diagnosis* rests upon the subjective group of symptoms enumerated above, and the objective manifestations noted in the laryngoscopic image.

The *prognosis* is favorable in mild idiopathic cases of diffuse laryngitis. It is favorable even in severe cases, if subjected to systematic laryngoscopic supervision. Neglected, such cases sometimes terminate fatally by suffocation for want of proper surgical interference. In deuteropathic cases, the prognosis depends largely on the disease of which the laryngitis is an epiphenomenon, but is rarely as favorable as in the idiopathic affection, erysipelatous laryngitis being of especially grave augury. In traumatic cases, the prognosis is favorable only when the injury has been unimportant. In all instances, acute laryngitis, unless skilfully handled, is liable to be followed by permanent malnutrition of the mucous membrane, rendering it liable to recurrence of subacute if not of acute inflammation, repetitions of which often merge gradually into chronic laryngitis. Chronic laryngitis thus induced, especially in persons with constitutions otherwise impaired, may, if neglected, terminate in ulceration. This opinion, however, is not shared by the profession generally; yet even chondritis and necrosis may follow acute idiopathic laryngitis. Sometimes, too, morbid growths become developed in immediate sequence to idiopathic laryngitis; while myopathic palsies of the vocal bands are occasional relics of the inflammatory processes.

In the already unhealthy subject, acute superficial laryngitis may be succeeded by abscesses, intra-laryngeal or peri-laryngeal.

Circumscribed laryngitis, being usually indicative of inherent or acquired cachexia, requires a much more guarded prognosis than the diffuse variety.

Treatment.—Whether mild or severe, small doses of mercuric chloride, in frequent repetition, seem to produce a decidedly beneficial effect on inflammations of the laryngeal mucous membrane, as upon the mucous membranes everywhere. Mild cases may be judiciously treated by the administration of an effective aperient, by restriction from butcher's meat, and by the continuous application of cold to the neck, whether by wet compresses, by bags of ice or of iced water, or by coils of rubber or of metallic tubing. Severe cases may require, in addition, leeching at the supra-sternal notch, and the systematic administration of salines, or even of antimonials, with still greater restriction in variety of diet. The food should be semi-solid, so as to guard the larynx from local irritation in swallowing. Inhalations of the vapor from steaming water impregnated with benzoin, creasote, or oil of pine, or with chamomile, sage, or the like, often afford great relief. Astringent sprays, unless quite weak, are not likely to be useful, and direct intra-laryngeal mopping is apt to be actually injurious. The accompanying pyrexia is perhaps best treated by minute doses of aconite at short intervals, until the pulse has become sensibly affected, and then at intervals sufficient to maintain the effect. Rest of the part and of the entire body, is indicated in all instances. Cases dependent upon dyscrasiæ require appropriate constitutional medication. Cases attended with great tumefaction require the surgical treatment detailed under œdema of the larynx (page 653).

Other Forms of Laryngitis.—*Submucous laryngitis*, more frequently regional than diffuse, is recognized by its greater tumefaction and by the proportional severity of its local and constitutional symptoms. It requires active antiphlogistic treatment and regimen. *Hypoglottic submucous laryngitis* is not clearly differentiable, clinically, from what has been described as subglottic œdema of the larynx (p. 648). Continuance of the tumefaction long after tracheotomy, is presumptive evidence of cell-infiltration rather than of effusion of serum.

Phlegmonous laryngitis exhibits still more urgent symptoms, and demands careful surgical supervision. *Ulcerative laryngitis*, and inflammation of the cartilages and of their investment, are mentioned in connection with the affections in which they are encountered.

Acute Infantile Laryngitis.—In children, acute laryngitis is much more severe than in adults. Not only is the inflammatory process more active, but the tissues possess a special sensitiveness, direct and reflex, which induces spasm of the glottis even on what appears the slightest provocation. These peculiarities add to the danger of the disease dependent upon the smaller proportionate calibre of the larynx. In children, too, slight initiatory distress often escapes detection, or may be purposely concealed by an imprudent nurse who has carelessly exposed the child to draft or dampness. Thus the severer symptoms are apt to occur with a suddenness which has been described as peculiar to the affection. In the majority of instances, however, strict inquiry will reveal the immediate precedence of a stomatitis, a coryza, a pharyngitis, or a bronchitis.

Symptoms.—It is usually at night that the severer symptoms alluded to are first manifested. These are paroxysmal cough and stridulous inspiration, with flushed face, accelerated pulse, difficult breathing, restless demeanor, and manifestations of pain in the throat, sometimes causing the infant to cry while grasping the neck after each paroxysm. The initial paroxysm usually subsides in a few seconds, and sleep is immediately resumed. Similar paroxysms recur at varying intervals, often with increasing frequency, and continue to recur for a day or two, or for several days, as may be. In some cases they are very slight and unimportant. In others they are severe and threatening. Suffocation occasionally results.

Diagnosis.—It is rare that laryngoscopy is available in children. The appearances noted in such an examination are mainly those mentioned in speaking of the laryngitis of adults. Paralysis of the posterior crico-arytenoid muscles has been detected occasionally, accounting for the stridor otherwise attributed to spasm of the glottis. The apparent suddenness of the attack, the character of the subjective symptoms, and the elicitation of tenderness or pain on pressing the larynx externally, suffice for the diagnosis.

Prognosis.—This is favorable in otherwise apparently healthy children. Recurrence and subsidence into chronic laryngitis are even more frequent than in adults.

Treatment.—Restriction in diet, moderately antiphlogistic measures, and the internal administration of antispasmodics, constitute the most effective means of treatment. Mercuric chloride is indicated, as in the adult. If the tendency to spasm be absent, cold may be applied externally, but if spasm be present, warm turpentine stupes are preferable. Sprays and intra-laryngeal applications are improper. Inhalations of vapor of warm water, simple or impregnated with soothing and balsamic drugs, are often useful. The warm bath is an excellent relaxant, and may be used systematically at intervals of four hours or longer. Relaxing inhalations of chloroform or of amyl nitrite may be necessary in the presence of threatening spasm of the glottis. Should the disposition to spasm be at all pronounced, precautionary tracheotomy will be indicated.

Chronic Laryngitis.

Chronic laryngitis may be idiopathic, deuteropathic, or traumatic. *Idiopathic chronic laryngitis* may affect the superficial layers of the mucous membrane only (*chronic catarrhal laryngitis*), or the glands likewise (*chronic glandular laryngitis*). The former variety may be a sequel of repeated attacks of acute laryngitis, or may occur in extension of a similar affection of the pharynx. Sometimes it appears due to the inordinate use of tobacco, or of alcohol, or of condiments. The latter variety is almost always an extension of a similar affection of the pharynx, and is most frequent in individuals who are compelled to make excessive use of the voice. Both varieties sometimes occur in association with chronic hyperæmia or inflammation of the gastro-intestinal mucous membrane. Males are affected more frequently than females, and adults more than children. *Deuteropathic chronic laryngitis* occurs in arthritis, tuberculosis, syphilis, lupus, sarcoma, and carcinoma, as part of their pathological history, and is sometimes a permanent sequel of the laryngitis of measles, scarlet fever, smallpox, croup, or diphtheria. It may be catarrhal, glandular, or suppurative. *Traumatic chronic laryngitis* occurs as a result of wounds and injuries sustained by the mucous membrane. It may be catarrhal and suppurative. All the varieties may be associated with tracheitis.

Chronic Catarrhal Laryngitis.—This is a chronic inflammation of the mucous membrane, sometimes attended with hypersecretion. Some capillaries and veins upon the surface are usually dilated, and in some cases even those in the submucous tissue. Erosions are infrequent. Infiltrations into the submucous connective tissue, and proliferations of the connective-tissue elements, are not uncommon; and permanent thickenings, circumscribed or diffused, regular or irregular in conformation, are occasional results. Permanent thickenings are more frequent in the deuteropathic varieties.

Chronic Glandular Laryngitis.—There is inflammation of the mucous glands, as well as of the superficial layers of the mucous membrane, and hyperplasia of their histological elements. Desquamation and degeneration of immature epithelium replace, in greater or less degree, normal secretion.

A peculiar variety of chronic glandular laryngitis—desiccative laryngitis, *laryngitis sicca*—occurs chiefly in females. The viscid products of secretion and desquamation adhere to the surface of the mucous membrane, and undergo desiccation there into annular and fragmentary fetid crusts, yellowish, greenish, or brownish in color, according to their admixture with mucus, pus, or blood. At intervals of a day, or of several days, these crusts are detached by violent efforts of cough, having sometimes become partially detached by superficial suppurative inflammation beneath them. Excoriations, in part hemorrhagic, are sometimes to be noticed at the points from which the crusts have been detached. The crusts themselves are composed of pus and mucus, and much more largely of desquamated epithelium, deformed, degenerated, and fatty. In most of the instances seen by myself, the crusts have occupied the mucous membrane in the domain of the cricoid cartilage and the upper rings of the trachea. In some they have occupied a ventricle; in others they have bridged the commissure between the vocal bands anteriorly. In a single instance—submitted for consultation by Dr. Smith, of Frederick, Maryland—the fetid laryngo-tracheal disease was associated with fetid rhino-pharyngitis. Similar instances have been cited by Fraenkel,[1] Moure,[2] and others.

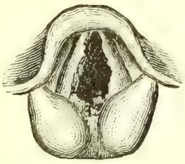
CHORDITIS TUBEROSA is the term applied by Tuerck[3] to designate a chronic inflammation of the vocal bands, characterized by minute whitish tumors or nodules on their upper surface. It seems to be peculiar to singers. In many instances the lesion is unilateral, the left band being affected most frequently. Its pathology is as yet conjectural. Local congestions, resulting from special vocal efforts during mild attacks of catarrhal laryngitis, may start local hyperplasias, terminating in permanent nodulations.

CHRONIC HYPERTROPHIC LARYNGITIS.—Occasionally in cases of non-constitutional origin, but more frequently in those dependent on tuberculosis and on syphilis, the tissues undergo hypertrophy. The lower or muscular structure of the vocal bands is the most frequent seat of this process, which sometimes induces sufficient constriction to demand tracheotomy.

CHRONIC TUBERCULOUS LARYNGITIS, in most instances eventually an ulcerative lesion, and frequently productive of perichondritis and necrosis, especially of the arytenoid cartilages, is usually due to secondary tuberculous infiltration. As inspected laryngoscopically, the pathologic processs in individuals with rapidly caseating pulmonary lesions, begins in a congestive catarrhal laryngitis, leading within a few weeks to the development of minute, non-suppurative ulcerations, upon the posterior surface of the epiglottis and elsewhere. These multiple ulcerations extend both in depth and in periphery, two or more coalescing when sufficiently close together, and then exciting contiguous suppurative ulceration in the adjoining tissues. Great swelling of the epiglottis gradually supervenes in many instances, and is in its turn sometimes followed by intumescence in the ventricular and vocal bands, and in the inter-arytenoid and aryteno-epiglottic folds. Ulceration, tuberculous and suppurative, takes place in some of these swollen tissues, particularly in the epiglottis, the arytenoidal extremities of the vocal bands, the internal face of the arytenoid cartilage, and the inter-arytenoidal fold; but it may take place anywhere.

In the more sluggish cases of pulmonary tuberculosis, beginning in localized pneumonitis, the earliest pathological manifestation in the larynx is pallor of the mucous membrane. Following this, the sharp outlines of the individual features of the larynx gradually undergo characteristic thickening, especially at points where lymphoid tissues predominate. The most marked manifestation is over the supra-arytenoid cartilages, whose sharply-defined, prismoidal outlines undergo transformation into pyriform swellings (Fig. 1054); the base of the morbid tumefaction occupying the apex of the normal structure, and tapering forwards along the fold stretching from the arytenoid cartilage to the epiglottis. The epiglottis sometimes becomes several times as thick as when normal. In the inter-arytenoid fold the tumefaction is sometimes diffuse, sometimes circumscribed. When circumscribed, it may be in an unbroken, spheroidally curved mass, or in a mass with

Fig. 1054.



Pyriform swellings of tuberculous laryngitis.

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[1] Ziemssen's Cyclopædia, vol. iv. p. 140.

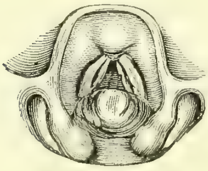
[2] Revue Mensuelle de Laryngologie, etc., Juin, 1883, p. 162.

[3] Op. cit., S. 164.

two or more acuminations. These tumefactions may continue the sole local manifestations of laryngeal tuberculosis; or extensive suppurative inflammations may take place upon their surface and in their substance. Perichondritis and necrosis are not uncommon, the posterior vocal process being attacked most frequently. Thence the disease is often propagated to the bodies of the arytenoid cartilages, which, undergoing necrotic destruction, may be expectorated in minute fragments, or in bulk. Necrosis of the cricoid cartilage is infrequent, and necrosis of the thyroid quite rare.

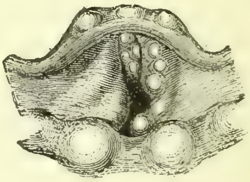
SYPHILITIC CHRONIC LARYNGITIS, often subacute rather than chronic, occurs both in the secondary and tertiary stages of syphilis. When occurring within a few months after the primary affection, it is presumptively secondary; when not occurring until after the lapse of a year or more, it is presumptively tertiary. The lesions of the one form sometimes run insensibly into those of the other, so that discrimination becomes quite impracticable. Mucous patches or papules have been detected laryngoscopically in many instances; and from their recognition an unjustifiable inference has been drawn that they are precursors of all laryngeal ulcerations in the secondary period. Very frequently, the history of exposure is the sole guide to early diagnosis, the local lesions being indistinguishable from those of non-syphilitic laryngitis until after ulceration has taken place. Symmetric, bilateral distribution of the ulceration, and symmetry in the patches of ulceration, may usually be regarded as factors in the differentiation of syphilitic from tuberculous laryngitis. Ulceration, of the epiglottis especially, is one of the earliest phenomena in the tertiary stage. Gummata are later manifestations as a rule. Deep and destructive ulceration is the ultimate outcome in the unarrested disease, and this leads to cicatricial stenosis in many cases of recovery.

Fig. 1055.



Gumma in inter-arytenoid fold.

Fig. 1056.



Multiple gummata. (Mandl.)

Gummata occur singly (Fig. 1055), or in groups, (Fig. 1056), some as small as millet-seed, some as large as hazel-nuts. The gummata are likely to undergo ulceration, and the process thus set up often extends to the cartilages, entailing great destruction of tissue.

Symptoms of Chronic Laryngitis.—The subjective symptoms of ordinary chronic, catarrhal and glandular laryngitis, comprise cough, hoarseness, and annoying sensations referred to the part, sometimes of dryness, sometimes as of the presence of a foreign body. In some instances they are slight; in some they are severe. There is no dyspnœa, little actual pain, and little expectoration. Secretion becomes more abundant under temporary conditions of exacerbation, after unaccustomed exposure, or during intercurrent attacks of bronchitis and subacute laryngitis.

Similar symptoms attend the deuteropathic varieties of chronic laryngitis, until such time as thickenings of tissue on the one hand, or ulcerations on the other, produce their characteristic manifestations of pain, dysphagia, and dyspnœa, with constitutional pyrexia. Swellings at the supra-arytenoid and arytenoid cartilages, and swelling of the epiglottis, produce difficulty in swallowing, while ulceration usually entails great pain in the effort. The dysphagia, first noted with liquids and subsequently with solids also, sometimes becomes extreme—especially in tuberculous laryngitis—aliments of all kinds being painfully regurgitated. Deep ulceration of the epiglottis, especially when lateral and extending along the fold of tissue which binds this part to the pharynx, is apt to induce intense pain running up into the ears, in the direction of the salpingo-pharyngeal fold; pain often more intense than that at the seat of the lesion. This pain is increased on deglutition. It is due, perhaps, to exposure of the auricular branch of the pneumogastric nerve at some portion of its course; for in some instances the pain is but slight, although the superficial ulceration may be extensive. Ulceration in the interior of the larynx produces much pain in some cases, and but little in others, so that this symptom is by no means proportionate to the amount of destruction. Ulceration of the vocal bands produces dysphonia, and sometimes aphonia, but here again the character of the voice is not indicative of the extent of the local lesion. Tumefaction of the ventricular bands, or of the inter-arytenoid fold, produces impairment of voice by interference with the vibration of the vocal bands, or with their due approximation; and tumefactions in both these localities, and in others which encroach upon the glottis, produce dyspnœa and stridor.

Diagnosis.—The subjective symptoms are sufficiently marked to indicate any form of the affection. In chronic catarrhal laryngitis, laryngoscopic inspection reveals diffuse congestion of the mucous membrane, often with dilatation of the capillaries on the epiglottis and on one or both vocal bands, the pearlish lustre of the vocal bands being often destroyed. The outlines of the laryngeal structures are usually somewhat, and occasionally much thickened. There is often considerable impairment in the movements of the vocal bands on phonation—sometimes due to thickening of their substance, sometimes to thickening of the inter-arytenoid fold, or even of the ventricular bands, and sometimes to infiltration in the muscles. The latter condition cannot be detected, but is inferred from the unequal movements of the two sides, the paretic manifestations being usually more marked on one side than on the other, and sometimes confined to one side exclusively. Erosions are sometimes noticed at the posterior portions of the vocal bands, and erosions or tears in the inter-arytenoid fold. Erosions are occasionally observed elsewhere. Accumulations of mucus are often adherent at projecting parts, and sometimes over a considerable extent of surface. When adherent to the vocal bands, or to the inter-arytenoid fold, they are liable to be mistaken for ulcerations. In chronic glandular laryngitis the enlarged glands can sometimes be detected on the surface of the mucous membrane, and even their orifices, it is said,[1] may sometimes be seen on the epiglottis and on the posterior parts of the vocal bands, appearing as pale specks on the congested mucous membrane, or as small red circles on the pale membrane.

The imperfectly annular crusts of desiccative chronic laryngitis are readily recognized in the laryngoscopic image, in most instances lining the cricoid cartilage, or some of the rings of the trachea, in whole or in part; and the fetid odor emanating therefrom is only too evident. The stenotic condition produced by chronic hypertrophy of the lower surface of the vocal bands—*chorditis vocalis hypertrophica*—is quite apparent, as shown in Figs. 1057 and 1058, taken from Tuerck, which present the laryngoscopic image both before tracheotomy and after it.

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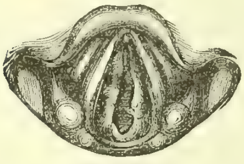
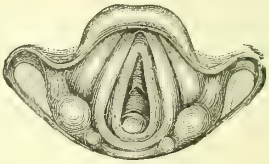
[1] Mackenzie, op. cit., vol. i. p. 291.

Fig. 1057.



Laryngoscopic image before tracheotomy. (Tuerck.)

Fig. 1058.

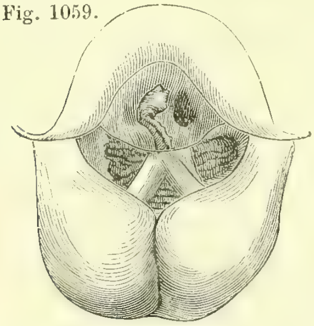


The same after tracheotomy; the canula in position. (Tuerck.)

The peculiar turban-like tumefactions of the epiglottis, and the characteristic pyriform swellings of the aryteno-epiglottic folds (Fig. 1059), are alike indicative of tuberculosis, a diagnostic inference usually to be substantiated by the result of a physical examination of the condition of the lungs.

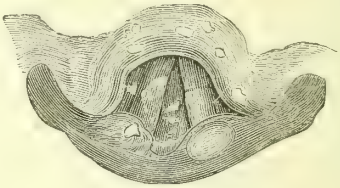
The minute, multiple ulcerations in the early stage of the more rapidly fatal cases, are often sufficiently characteristic (Fig. 1060) to indicate the nature of the lesion.

Fig. 1059.



Tuberculous laryngitis, ulcerative stage.

Fig. 1060.



Multiple ulcerations in laryngeal tuberculosis. (Mackenzie.)

Recognition of the lesions mentioned, and a syphilitic history, or, in its absence, evidence of syphilitic lesions elsewhere, present or past, serve to determine the nature of a chronic laryngitis in syphilitic subjects. In addition to symmetry in ulcerative lesions, the presence of pus upon them may be distinctive. Ulceration of the epiglottis, especially from above downward, is usually indicative of syphilis, particularly when apparently a continuation of a similar lesion in the pharynx. Nevertheless, such lesions occur in tuberculosis likewise. In case of doubt, the detection of a pulmonary lesion at the apex of the lung may usually be regarded as evidence of tuberculosis, the analogous pulmonary lesion of syphilis being much more frequent toward the middle portion of the lung. Furthermore, syphilis and tuberculosis may coexist, and then the characteristic lesions of the two become commingled.

Prognosis.—In simple, uncomplicated cases, the prognosis is favorable, recovery taking place under proper regimen and assiduous topical and constitutional treatment. It is much less favorable in cases which are the direct sequelæ of measles, smallpox, diphtheria, or traumatism, though still susceptible of considerable amelioration. In none of these instances is the laryngitis directly menacing to life. It is liable, however, to excite the development of neoplasms, usually clinically benign, a result which temporarily or permanently increases the gravity of the prognosis.

When the muscular tissue of the vocal bands is involved in the process, as manifested by tumefaction on their inferior surfaces extending beyond their normal borders, the prognosis is unfavorable, this condition rarely subsiding. Indeed, the induced dyspnœa often demands tracheotomy, usually with little prospect of the patient being able to dispense with the canula.

True or false anchylosis of the crico-arytenoid articulation is an occasional result of chronic laryngitis of constitutional origin.

In cases attended by profound dyscrasia of whatever origin, perichondritis, abscess, chondritis, and necrosis, are imminent, and their advent renders the prognosis unfavorable.

The chronic laryngitis of tuberculosis is of very grave augury, as the impression of the diathesis is usually so strong as practically to preclude recovery, even though ulcerative processes may undergo intercurrent repair. Ulceration limited to the epiglottis indicates a much more rapid termination than ulceration in the interior of the larynx. Few cases survive the eighteenth month of marked laryngeal disease. The chronic laryngitis of syphilis is quite prone to cause ulceration, the cicatrization of which may produce stricture. In malignant disease, the prognosis is necessarily unfavorable.

Treatment.—Hygienic measures as to dress, ventilation, and ablutions, and dietetic regulations adapted to the impaired functions of the gastro-intestinal tract, are essential in very many instances. Everything known to induce temporary exacerbation of the malady should be avoided to the utmost limit practicable. Constitutional imperfections should be inquired into, and remedied by appropriate measures, medicinal and otherwise. Systemic measures alone, judiciously as they may be instituted, rarely suffice without topical treatment. The general recognition of this fact has led to the use of a greater variety of local measures than has perhaps been employed in the treatment of any other malady. Much must be done by the medical attendant; much can be left to the patient and the nurse. The condition of excessive or diminished secretion furnishes the chief indication for home-treatment, the object of which should be to keep the parts clean and sweet, and thus give them a chance to get well. Alkalies augment secretion from the mucous membrane, and facilitate its detachment. Hence alkaline sprays, insufflated or inhaled at regular intervals, are indicated in cases of deficient secretion. An aqueous solution of ammonium-chloride, five grains to the ounce, inhaled for three or four minutes four times a day, often answers admirably. Sodium-borate, five grains to the ounce of tar water, with the addition of a drachm of glycerine to facilitate solution, is the remedy most in use by myself. Sodium-bicarbonate, sodium-chloride, sodium-chlorate, sodium-iodide, potassium-iodide, or potassium-chloride, may be substituted in the same doses when either of the other agents fails. In some cases vegetable promoters of secretion, such as pyrethum and jaborandi, may be more serviceable, from one to five minims of the fluid extract to the ounce of water. When indicated, watery extract of opium may be added to relieve pain. A few drops of Cologne water or of some balsamic may render the spray more agreeable. When secretion is excessive, weak mineral astringents are indicated: zinc-sulphate, or zinc-sulphocarbolate, two grains to the ounce of rose water; alum, five grains to the ounce; ferric chloride, one grain to the ounce; or silver-nitrate, half a grain to the ounce. Inspirations of these sprays should not be sufficiently powerful to draw the medicament into the bronchi. The tube of the instrument should be held several inches from the mouth, so that the misty spray that falls may be deflected into the throat and larynx by the ordinary breath of inspiration. When the tube is placed within the mouth, the greater portion of the spray is condensed upon the pharynx, and does not reach the larynx at all. The face and teeth should be protected from stains of iron and silver by directing the spray through a large glass speculum held between the teeth. Exposure to the outside air should be avoided for half an hour, in case a steam apparatus is used. The ordinary hand-ball instrument is all that is required, for little benefit and some harm may result from the relaxing influence of warm sprays in chronic affections.

In cases of several months' duration, these remedies need to be supplemented by topical astringent and alterant treatment at the hands of the surgeon. The agents most frequently employed by myself are tannin, silver-nitrate, or zinc-sulphate, in uncomplicated cases; iodine, or iodine and carbolic acid, in cases with submucous tumefactions; iodoform in tuberculous cases; and iodoform and acid solution of mercuric nitrate, one part to ten or twelve of water, in syphilitic cases. Syphilitic ulcerations often heal under constitutional treatment without any topical medication whatever. Zinc-chloride and ferric sulphate have not been as useful, in my hands, as tannin, zinc-sulphate, and silver-nitrate. Boric acid has been lauded as a substitute for iodoform in tuberculous cases. Carcinomatous cases are not suitable for active topical treatment. Before making any application, the parts should be thoroughly cleansed with an alkaline spray, such as those already indicated, to which tar water or an emulsion of coal-tar may be added to soothe and disinfect, or with a spray of the solution of hydrogen-peroxide, the best cleanser I have knowledge of, one part of a ten-volume solution to three or four of distilled water. The latter is especially serviceable in cleansing ulcerated surfaces. The entire series of manipulations should be performed with the aid of laryngoscopy. The silver-nitrate, forty grains or more to the ounce, is applied with a brush for a gentle application, or with a firmly secured fragment of the best surgical sponge, used but once, for a thorough one. With a properly curved forceps, toothed to prevent danger of dropping the sponge into the larynx, and firmly locked by a slide-catch, the fragment of sponge may be as small as desired. When a sponge the size of a pea or larger is passed into the larynx, muscular contraction is excited, and a great extent of mucous membrane comes in contact with the remedy. This contraction often amounts to spasm, especially at the initial operation. Hence the solution should be extremely weak at first, say ten grains or less to the ounce, and the strength should be increased only as tolerance is acquired. Sudden death by suffocation has been known to follow the incautious use of this agent.[1] Tannin, best perhaps as a saturated glycerite, may be employed in the same way. Zinc-sulphate, thirty grains to the ounce, propelled on the parts by douche or spray, seems to afford better results than applications by brush or sponge. Silver-nitrate in my own hands is reserved for cases in which the zinc-sulphate has failed. Iodoform or boric acid, in impalpable powder, may be blown upon the parts from a curved tube, as much being used (a grain or more) as is requisite to cover the ulcers. The surgeon's mouth is the most accurate propeller, but his mouth-piece should be provided with a valve to protect him from a return current from the throat of the patient. In many instances several attempts will be neces-

[1] Archiv. f. klin. Chirurgie, Bd. xxxvii. S. 570. 1882.

sary to cover the parts, for cough, often beyond the patient's control, expels the powder. In some cases the powder will not stick to the parts, no matter how passive the patient may be. Great variation in this respect is to be noted in different subjects. A saturated ethereal solution of iodoform, applied with brush or sponge, or even in spray, may be substituted for the powder. When there is great pain due to ulceration, powders containing from one-eighth to one-fourth of a grain of morphine may be propelled upon the parts once a day or oftener. Morphine may be combined with the iodoform. The mercuric nitrate should be carefully applied with a minute fragment of sponge securely attached to a holder, or with the point of a delicate brush. Contact with the ulceration should be positive and momentary, and withdrawal quick. The agent is not safe in the hands of an inexperienced manipulator.

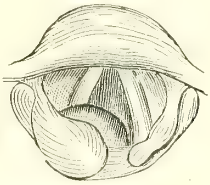
Abscess of the Larynx.

Abscess of the larynx may be *intra-laryngeal* or *peri-laryngeal.* One variety of the latter form, confined to the posterior surface, is sometimes mentioned as *retro-laryngeal.* Laryngeal abscess is usually a secondary affection, most frequently a result of perichondritis. Primary circumscribed abscess is infrequent. As determining causes may be mentioned, phlegmonous and traumatic laryngitis, tuberculosis, syphilis, glanders, smallpox, measles, typhus and enteric fevers, and pyæmia. Abscess of the larynx in enteric fever, appears to be much more frequent on the Continent of Europe than in America. The inferior laryngeal face of the epiglottis, the internal face of an arytenoid cartilage, and the ventricular band, are the most frequent seats of circumscribed abscess not the result of injury; but abscess has likewise been noted over the supra-arytenoid cartilages, and on the internal face of the aryteno-epiglottic and the inter-arytenoid folds. When not the result of perichondritis, these abscesses are attributed to inflammation of the submucous tissue and the mucous glands at those localities. Exceptionally, an intra-laryngeal abscess points externally. The pus discharged is usually sanious. The amount is rarely large, but Navratil[1] mentions an abscess of the right ventricle which discharged an ounce of blood and pus spontaneously on the sixteenth day of the disease.

Symptoms.—The local symptoms are pain, dysphonia or aphonia, cough, dyspnœa, and dysphagia. When at all large, the dyspnœa may become extreme, and even suffocation may be threatened.

Diagnosis.—In intra-laryngeal abscess the diagnosis rests almost entirely upon laryngoscopic inspection. The collateral inflammation is sometimes so great as to prevent detection of the abscess; but usually it can be recognized as a glistening, circumscribed tumefaction, red at the base, and red or yellowish at the apex. (Fig. 1061.) It is liable to be confounded with œdema. Partial or complete anchylosis of the arytenoid cartilage is often noted in cases due to perichondritis of the cricoid and arytenoid cartilages. In the absence of laryngoscopic inspection, circumscribed pain alone may indicate the existence of an abscess.

Fig. 1061.



Abscess from perichondritis of arytenoid cartilage.

Peri-laryngeal abscess is indicated by peri-laryngeal tumefaction with fluctuation on pressure.

Prognosis.—The prognosis is favorable in intra-laryngeal abscess, if the diagnosis has been made; as measures can be instituted at once to avert any risk of death by suffocation. Death has occurred in this way both by the abscess itself and by collateral œdema; but, in the cases recorded, the nature of the affection had not been made out during life. Spontaneous discharge often ensues; the contents being ejected by cough, with immediate relief to the subjective symptoms. The ultimate prognosis depends upon the nature of the disease or injury which has given rise to the abscess. In some instances, a second abscess will be developed within a week or two after the discharge of the first; and this may be followed by one or two more at intervals of several weeks or of several months. Stenosis of the larynx is an occasional sequel of abscess. In peri-laryngeal abscess the prognosis is dependent upon the nature of the disease which has occasioned it.

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[1] Laryngologische Beitrage, S. 20. 1871.

Treatment.—Under favorable circumstances, an intra-laryngeal abscess can be punctured or incised with a properly curved knife, guided by laryngoscopy. Should this operation be impracticable, a precautionary tracheotomy will be indicated under conditions of dyspnœa threatening death by suffocation.

Peri-laryngeal abscess is treated by incision at the most accessible point, as far as practicable in the middle line.

PERICHONDRITIS AND CHONDRITIS.

As far as is known, chondritis is always preceded by perichondritis. Perichondritis is commonly deuteropathic or traumatic in origin. Primary perichondritis, usually attributed to great exposure to cold and moisture, and occasionally to over use of the voice, is very rare. Even cases supposed to have been of this nature have eventually proved to be deuteropathic.[1] It occurs much the most frequently in tuberculosis; and to a less extent in syphilis, typhus and enteric fevers, variola, diphtheria, scarlatina, lupus, pyæmia, carcinoma, and traumatism. Occasionally it is a direct sequel of protracted chronic laryngitis. Except in cases occurring in enteric fever, when adolescents and young adults are most liable, it is more frequent in adults than in children, and most frequent between the ages of twenty-five and forty. In enteric fever the process rarely begins before the second week; but it may not be noticed until the period of convalescence. Some authors attribute perichondritis to ulceration progressing from the mucous membrane. Others attribute this ulceration to precedent perichondritis. The conclusion is that inflammatory processes may originate in the perichondrium, or be a result of transmission by contiguity. The cricoid and arytenoid cartilages are the most frequent sites of the process—the former in its posterior segment especially—a fact unsatisfactorily accounted for by its dependent position in recumbency, and its pressure against the vertebræ, as claimed by some observers. The thyroid cartilage is attacked far less frequently, and the epiglottis only exceptionally. Suppurative inflammation soon loosens the perichondrium from the cartilage, which then undergoes necrosis from innutrition, without actual inflammation. The suppurative process develops an abscess which breaks through the superjacent soft tissues, sometimes externally, oftener internally, and then the necrosed cartilages are often discharged —in detritus, in fragments, or in bulk, as may be. Intercurrent infiltration of the intra-laryngeal soft tissues may produce acute stricture; and should the process eventuate in permanent hyperplasia, whether of soft tissues or of cartilage, chronic stricture or stenosis may result. In tuberculosis and even in typhosis,[2] the arytenoid cartilages are frequently discharged entire.

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[1] Hall, Brit. Med. Journal, May 6, 1882, p. 660; and April 26, 1884, p. 814.

[2] Chvostek, Centralblatt für die med. Wissenschaften, No. 11, 30 Dec. 1883.

Similar exfoliation of the cricoid has been reported by Hunter,[1] and by myself.[2]

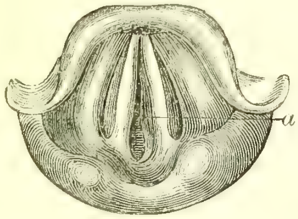
A very circuitous route to the exterior is sometimes taken. Thus an abscess, originating at the posterior portion of the cricoid, may point in the pre-thyroid region.[3] Fistula often results, and extensive emphysema may thereby ensue. Durham reports an instance[4] in which the emphysema was more extensive and general than in any other case of any kind which had come under his observation.

Perichondritis of the thyroid cartilage, suppurating with pointing of the abscess externally, sometimes occurs independently of disease of the interior of the larynx. In an instance noted by Dr. Gibb,[5] the pus had a peculiar blue color.

Symptoms.—The symptoms are much the same as those of severe acute or chronic laryngitis, with pain, elicitable on pressure externally, and sometimes in deglutition and in phonation. Should the disease progress, hoarseness, cough, and dysphagia soon occur; then dyspnœa, perhaps, with stridulous respiration or paroxysmal apnœa; and eventually symptoms of stricture. Discharge of the abscess excites cough and expectoration, followed by great subsidence in the local distress. Should fragments of cartilage become lodged in the chink of the glottis, suffocative apnœa may ensue.

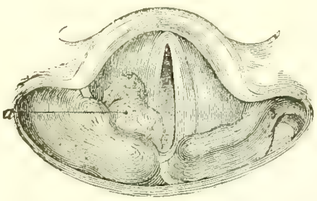
Diagnosis.—The location of the pain, whether spontaneous or elicited by palpation, often indicates which cartilage is affected. Laryngoscopic inspection reveals local tumefaction or abscess in the domain of the diseased cartilages. Perichondritis of the cricoid will be indicated by swelling beneath the vocal bands, sometimes posteriorly, and sometimes at the side. (Fig. 1062.) When an arytenoid cartilage is involved, the abscess points above the vocal bands—as it does sometimes when both cartilages are implicated. (Fig. 1063.) Sometimes the collateral œdema is so great as to obscure the characteristic tumefaction. Arytenoidal disease is usually indicated further by lack of movement of the corresponding vocal band, or by actual anchylosis of the crico-arytenoid articulation. After discharge of an abscess, a probe can sometimes be brought into contact with necrosed cartilage. Perichondritis of the thyroid cartilage often produces swelling externally, through which the denuded cartilage may be detected with an exploring needle.

Fig. 1062.



Primary perichondritis of cricoid cartilage (Tuerck.) *a*, inner wall of abscess.

Fig. 1063.



Perichondritis of cricoid cartilage, with loss of arytenoid, in enteric fever. (Tuerck.) *a*, wall of abscess.

Prognosis.—While the prognosis may be favorable in idiopathic or primary perichondritis, and even in traumatic cases, it is almost always unfavorable in deuteropathic or secondary cases. Few patients recover, and many that survive, suffer with a permanent stricture. Defects in the cartilage are sometimes repaired by connective tissue.

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[1] Cited by Rühle (Die Kehlkopf-krankheiten. Berlin, 1861).

[2] Transactions of the Pathological Society of Philadelphia, p. 148. 1874.

[3] Robinson, Am. Jour. Med. Sci., April, 1875, p. 399.

[4] Op. cit., 3d ed., vol. ii. p. 688. London, 1883.

[5] Brit. Med. Journal, Dec. 13, 1873, p. 684.

Treatment.—In primary perichondritis, antiphlogistic treatment is indicated; cold should be applied externally, and by frequent deglutition of ice; and the same surgical supervision is required as in other forms of acute laryngitis. At a later period, should the disease continue, the treatment would merge into that to be adopted in deuteropathic cases: namely, the administration of tonics and stimulants, with food by the rectum or stomach-tube, when required; precautionary tracheotomy, to avert suffocative apnœa—tracheotomy is here preferable to laryngotomy; early incision of abscesses; and removal of loose fragments or cartilages. The treatment for strictures, in cases that survive, has been indicated at page 686.

CROUP AND DIPHTHERIA.

From a surgical point of view, the main interest in croup and diphtheria centres in the question of tracheotomy, which may be discussed independently of any consideration as to the identity of the affections. The first successful tracheotomies in modern times, for croup or diphtheria, seem to have been performed shortly before 1730, one of them by Dr. George Martine, who describes[1] a case of croup which, from the healthy appearances of all parts in view, he inferred to be "an angina of the most malignant type (*Angina sine tumore*, of Hippocrates)," and mentions earlier successful operations by Mr. Baxfer and Dr. Oliphant. Two objects are attainable by this operation: first, the removal of false membrane through the wound, and second, the establishment of a tract for respiration below the point of obstruction. Should the obstruction be in the bronchi, but little benefit can be anticipated. The proper moment for surgical interference, a matter of serious import, has long been a subject of debate. Performed too early, tracheotomy may expose the patient to unnecessary peril; performed too late, it may be worse than useless. Yet it may be safely stated that there are no positive contra-indications to the procedure, save evidence of accumulations of fibrin in the cavities of the heart. Here death by syncope is inevitable, and the knife can afford no relief to the cardiac obstruction. Continuous and increasing dyspnœa of mechanical origin, at any stage of the disease, which resists the influence of less radical measures, is indicative of obstruction to respiration, sufficient to justify the operation. Little is to be gained by waiting, and much may be sacrificed.

Two sets of symptoms occur, dependent upon the location of the obstruction. In one, the dyspnœa is continuous and progressive, but there are no violent struggles for breath; air reaches the lungs, though in restricted areas. There is no inspiratory depression of the soft tissues above the sternum, and but little, if any, below the diaphragm. The respirations are frequent and shallow; the pulse is small and frequent; the skin is livid, cold, and perspiring; the face is swollen; the eyes are listless and their pupils dilated; the finger tips are blue at the nails; the mucous membrane within the mouth is pale; sensation is dulled. False membrane occupies the bronchial tract, plugging some passages and obstructing others, so that air cannot reach the pulmonary vesicles in quantity sufficient to maintain the interchange essential to due hæmatosis. This form of apnœa is regarded by many as a contra-indication to tracheotomy, although the operation has occasionally saved life even when the symptoms have been at their worst. The other set of symptoms attends more rapid suffocation, with paroxysmal apnœa. The agitation is great; orthopnœa is marked; the struggles for breath are intense; the sub-thoracic tissues are deeply indented with each inspiration, and, at a later stage, the supra-sternal tissues likewise; inspiration is noisy and stridulous; the pulse is small and quick; the cervical veins are swollen; the face is turgid, flushed at first and subsequently cyanosed; the eyes are suffused and prominent; the skin is warm and moist; the mucous membranes are blue; the vesicular murmur is faint or absent. The false membrane occupies the larynx, or the larynx and trachea. These cases are considered favorable for tracheotomy; and on its performance the morbid respiratory phenomena subside. The presence of pseudo-membrane is not the only indication for operation. Whether false membrane be present or not, recurring spasmodic constriction of the glottis, or paralysis of the dilating muscles, may threaten suffocation, avertible only by tracheotomy.

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[1] Philosophical Transactions, vol. vii. No. 416, p. 448. 1719–1733; cited in a private letter from Dr. John R. Quinan, Baltimore, Nov. 23, 1883. See also Quinan, Maryland Medical Journal, Dec. 1, 1883, p. 512.

In a study made by me, in 1873,[1] of more than five thousand operations for croup and diphtheria, it became apparent that about one case in four recovered after tracheotomy, although several series of individual statistics presented much more favorable results. Thus a few meagre records may be cited in which all patients were saved—two each by Buck, Cabot, and Balassa; and a number in which more than one-half were saved, as the 6 out of 7 by Schoellhammer; 3 out of 4 by Baudin; 8 out of 11 by Cruickshank; 4 out of 6 by Gerdy and Bardinet; 2 out of 3 by Perrochaud; 6 out of 9 by Cheever; 11 out of 17 by Von Köpl; 10 out of 16 by Bourdillat; 3 out of 5 by Moynier; 5 out of 9 by Petel and by Richet; and 13 out of 23 by Calvet. The figures are reproduced to show that combinations of circumstances may produce unusually good results, and that no hard and fast rule can be deduced from mere statistics. A favorable age in the patient, a judicious selection of cases, a happy recognition of the proper moment for surgical interference, skilful operation and assiduous attention afterwards, may have formed the combination productive of this exceptional experience. There is no reason to believe that any of these tracheotomies were needlessly performed, or that unusual success was due to luck.

The proportions of recoveries at the hands of these operators may have been increased by subsequent operations. Most likely they have been diminished; as several series have had to be dropped from my original list[2] for this cause.

Indeed, personal inquiry has convinced me that particularly brilliant series of successes are rarely maintained for long terms of years. Thus an enthusiastic advocate of the operation in Philadelphia, who had saved three out of the four children upon whom he had performed the operation up to the time alluded to, informed me a few years afterwards that he had done seven tracheotomies since then, and had lost every case. His successes had fallen from 3 in 4, to 3 in 11. A physician in New York, the statistics of whose operations were presented with a record of 13 successes out of 67 operations, told me, some years ago, that after his record had been published he had done more than one hundred unsuccessful operations before he had been able to add another recovery. His successes, then, were temporarily reduced from 13 in 67, to 13 in 167. These illustrations are mentioned, not in discouragement of the operation, but in deprecation of extravagant claims for it.

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[1] Croup, in its relations to Tracheotomy. Philadelphia, 1874.

[2] Op. cit., p. 26.

It is neither to be regarded as a routine procedure nor as a last resort. It is a legitimate therapeutic measure, with a definite purpose. The special indication cannot be formulated by an inflexible rule. The good judgment of the surgeon must be his guide. The most favorable moment for interference, is when the surgeon begins to think that the patient cannot live without it; but recovery follows occasionally, even when the operation has been postponed until immediately after apparent death.

Comparatively few children under two years of age are saved, not many over eight or nine, and adults only as the exception. The adult larynx is so large that it rarely becomes at all occluded in diphtheria, until such a late date that fatal blood-poisoning has occurred in the normal progress of the disease.

That operations are by no means hopeless at the earlier age referred to, the following record, amended from my own essay,[1] will abundantly testify. Thus successes are reported at six weeks by Scoutetten; at three months by Annandale;[2] at five months by Croft;[3] at six months by Kisler;[4] at seven months by Bell, Tait, and at Langenbeck's clinic;[5] at eight months by Elias;[6] at nine months by Steinmayer;[7] at ten months by Baizeau, Dujardin, Bourdillat, Foster, Greenfield,[8] Elias, and Winiwarter; at 11 months by Shrady,[9] and in a case operated upon at the Boston City Hospital;[10] at 13 months by Trousseau, Barthez, and Archambault; at 14 months by Millard and Henry;[11] at 15 months by Baizeau and a colleague of his; at 16 months by Isambert and Potain; at 17 months by von Vigla and Jacobson;[12] at 18 months by Moutard-Martin, Potain, and Archambault; at 19 months by Pancoast; at 21 months by Sendler, Waren Tay,[13] and Mayer;[14] at 22 months by Labord, Isambert, and Parker;[15] and at 23 months by Labord and Malshieurat-Legrand.

On the other hand, I have been unable to find more than three successes recorded in adults; 1 by Quain;[16] 1 by Lloyd,[17] and 1 by Nussbaum.[18]

The successful completion of the operation does not terminate the surgeon's responsibility. He must protect his patient from suffocation, which is liable to ensue by occlusion of the artificial opening just made. First of all, he must search the air-passages for pseudo-membrane, just as he would were they obstructed by any other foreign body. The edges of the incision being held apart, by hooks, ligatures, or simple or special retractors—of which the retractor devised by Mr. Golding-Bird (Fig. 1042, p. 676) is probably the best—forceps are to be introduced, to search for false membrane and extract it. For obvious reasons the first search is made below the wound, and the larynx is explored afterwards. Suction at the wound with the mouth, is probably the most efficacious method of withdrawing fragments of pseudo-membrane, but it is not safe. Infection and death therefrom may follow. More than one surgeon has sacrificed his life in this manner, and has failed to save his patient.

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[1] Op. cit., p. 24.

[2] The child lived seven weeks. Edinburgh Medical Journal, p. 1121. 1862.

[3] Lancet, November, 1880, p. 849.

[4] Deutsche med. Woch., No. 45. 1878.

[5] Krönlein, Arch. f. klin. Chir., Bd. xxi. S. 253. Eighty-five operations in children under two years, with eleven recoveries, one at seven months.

[6] Deutsche med. Woch., No. 45. 1878.

[7] Berliner klin. Woch., No. 20. 1880.

[8] Saint Thomas's Hospital Reports, vol. viii. p. 261. 1878.

[9] Medical Record, November 4, 1882, p. 512.

[10] Gay, Medical News, July 12, 1884, p. 33.

[11] Journ. de Thérap., Août, 1874, p. 561.

[12] Medical Record, June 30, 1883, p. 705.

[13] British Medical Journal, September 16, 1882, p. 523.

[14] Medical Record, April 26, 1884, p. 457.

[15] Saint Bartholomew's Hospital Reports, vol. xviii. p. 323. 1882.

[16] Jenner, Diphtheria, its Symptoms and Treatment. London, 1861.

[17] British Medical Journal, October 16, 1875, p. 513.

[18] Werder, Pittsburg Medical Journal, February, 1883, p. 46. The operation was undertaken after apparent death, and artificial respiration was maintained for fifteen minutes.

Suction with a syringe, the nozzle of which has been encircled at a convenient point with a section of rubber tubing just thick enough to fill the incision nicely, is an admirable substitute for suction by the mouth, the risk from which is unjustifiable, even though performed through the medium of a catheter with a globular offset at the side, to catch the matters withdrawn and thus protect the mouth. A flexible catheter may be attached to the nozzle of the syringe, and may be introduced into the trachea after reinforcement with rubber tubing to occlude the artificial orifice. On drawing the piston of the syringe, fragments in contact with the eyes of the catheter are apt to become engaged therein, and may thus be readily withdrawn. Furthermore, the cough which is excited sometimes drives obstructing products through the artificial opening. It is desirable to explore each primitive bronchus in turn. This surgical clearance is far preferable to the slow clearance following the usual dependence upon nature's unaided efforts. It adds little local irritation, if any, and diminishes the sources of exhaustion. Re-accumulations of pseudo-membrane, resisting voluntary expulsion by cough, should be subjected at intervals to gentle manipulations of the same kind. Even the mere introduction of an elastic catheter sometimes excites expulsive cough with discharge of membrane, blood, and mucus. Foreign products having been withdrawn, the question arises as to the best method of keeping the artificial opening patulous. If the surgeon, or an equally responsible and efficient substitute, will remain by the patient for a few hours, the retractors may be retained in position without any attempt to introduce the canula. This practice will facilitate expulsion of membranes, a process always impeded to some extent by a tube in the trachea, the presence of which renders it necessary that any matters expelled shall be driven through it. Thus many ineffectual paroxysms of coughing, often exhausting to the patient, precede the successful one which gives relief. In a few hours, however, the permanent method of keeping the trachea open is to be decided on. In most instances, the delay recommended above is not made, but the permanent arrangements closely follow the operation. They depend somewhat on the character of the operative procedure which has been adopted. The operation in frequent practice is longitudinal incision of the trachea in the median line, for a distance comprising three interspaces or even three rings. Most surgeons incise the trachea as high as possible; others as low as possible. Some divide the cricoid cartilage; others the cricoid cartilage and a ring or more of the trachea. Some excise a portion of the anterior wall of the trachea, the incision being elliptic, oval, rectangular, or diamond-shaped. Some excise the anterior wall of the cricoid cartilage, whether with preservation of its perichondrium or without. Division of the cricoid-thyroid membrane is rarely practised in croup and diphtheria. The majority of operators introduce a rigid, curved tube or canula into the trachea, whether incision or excision has been practised. Some dispense with a tube altogether, and, when excision has not been practised, resort to hooks and ligatures to keep the opening patulous. It would be very desirable to dispense with a tube; but so great is the risk that the orifice in the trachea may become overlaid by the soft parts in some of the movements of the child, especially during sleep, and thus suffocate the patient, that continuous supervision of the opening is essentially requisite. The attention of the best of nurses, trained or domestic, is occasionally unwittingly drawn from the orifice, and, during such inattention, suffocation may take place. It is, therefore, safest to employ a tube.

The operation over, the indications remain for continuing the supporting measures and the anti-diphtheritic medicinal treatment already adopted. Tracheotomy saves a patient from death by suffocation. It does not cure the disease.

After-treatment in Cases of Tracheotomy for Croup or Diphtheria.—Much of the success in tracheotomy for croup and diphtheria, depends upon the efficiency of the treatment after the operation. Much of the want of success previous to 1850, or thereabout, was due to lack of recognition of this fact. The operation and the subsequent manipulations being completed, the patient should be put to bed in an apartment at a temperature of not less than 70° F.; for a certain amount of chilliness usually ensues, often proportionate to the amount of hemorrhage during the operation, and to the intensity of the dyspnœa before it. The external opening should be covered with a fold of woollen gauze or scarf, straddled upon a tape or a strip of plaster applied above the wound. This protects the trachea from dust, and warms the air a little, as it is inhaled. The risk of pneumonia is thereby lessened, and the liability diminished to clogging of the tube by accumulations of desiccated crusts and fragments of false membrane. The atmosphere of the room should be kept moist as well as warm. The evolution of steam in the immediate vicinity of the patient will effectually warm and moisten the air he breathes. In the absence of facilities for making steam, flat sections of sponge wrung out of hot water should be kept over the tube. If reaction from the chill be tardy, warm, aromatic drinks should be administered, and flying sinapisms should be applied to the trunk and limbs. Under their influence, restlessness subsides and sleep ensues. Sleep, indeed, often comes on before the dressings are completed; occasionally on the operating table, as soon as the canula has been inserted. Inhalations of steam and of the vapors of slaking lime are as useful to detach the pseudo-membrane after the operation as before it. Indeed, it deserves especial mention in passing, that I know of no one agent so useful in detaching pseudo-membrane from the larynx and trachea, as copious inspirations of the vapors arising from lime in the process of slaking, as suggested by Dr. Geiger,[1] of Dayton, Ohio. I feel assured that, in my own hands, the remedy has saved a number of children from the necessity of undergoing the operation. Its action seems altogether mechanical, small particles of lime prying up the edges of the partially detached shreds, so that the watery vapor gets under them and accelerates their separation. A small piece of lime in a pail of water is of no use. Several lumps of lime, the size of a small fist, should be placed in a bucket by the side of the bed. Hot water should be poured upon them till they are barely covered. A funnel-shaped hood of newspaper, or a stout paper bag with one corner cut off, should be inverted over the vessel, with the outlet directed towards the patient's mouth. In a few minutes there is a copious evolution of vapors charged with lime, which rush through the orifice and are inhaled. The patient's eyes should be protected from the particles of lime. Cough is excited, and sometimes emesis, and with the cough large quantities of false membrane are expelled, if any have been present. Each inhalation consumes some ten or twelve minutes; and the process is to be repeated at intervals of half an hour, or less frequently according to the indication. Used in this manner, inhalations of lime will disappoint expectation much less frequently than the slaking of one small fragment at a time, or the use of lime-water in spray.

The expectorations are at first mingled with blood which has trickled into the air-passages. They often become mucous, thick, and opaque, sometimes forming large, irregular masses. Sometimes they remain semi-transparent and fluid, though viscid. These are the characteristics of laudable expectoration. The trickling out, without cough, of serous, grayish, fetid and non-aërated products, is an unfavorable prognostic. If there be no cough, the prognosis is bad; for mere drainage is insufficient to prevent gradual apnœa.

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[1] Medical and Surgical Reporter, March 24, 1866.

The removal of the pseudo-membrane probably produces some excoriation of epithelium, and it is in part due to the reparative process in that tissue that those discharges take place, which in desiccation form the coriaceous crusts which so often accumulate shortly after the operation. The inspiration of warm and moist air tends to retard this desiccation, and favors the removal of these products by cough. Cough is therefore a good prognostic. When the secretions accumulate in threatening quantity, it is better practice to attempt their mechanical removal by aspiration, than to trust to the uncertain influence of medicinal expectorants.

Traumatic fever is usually manifested within a few hours after the operation, sometimes within an hour. The greater the dyspnœa and hemorrhage have been, the later, as a rule, the febrile reaction. In favorable cases this fever subsides within a day or two. Its persistence indicates some unfavorable complication. Sometimes it is sufficiently violent to prove fatal within twenty-four hours. Should the respirations exceed forty in the minute during sleep, after subsidence of this fever, pneumonia is to be dreaded. A pulse exceeding 160 in the minute, a temperature exceeding 102° F., and a sudden rise in temperature, are likewise indicative of impending complication.

Diarrhœa and vomiting, a few hours after the operation, are to be expected in children to whom ineffective emetics have been given, as the re-establishment of respiration promotes the absorption of drugs already in the alimentary tract; hence the inference that such remedies should not be pushed, when once they have proved ineffective.

The appetite is usually good for two or three days, but then it often becomes poor, usually in advance of some impending complication. Abundant nutrition is necessary. Every effort should be made to give food by the mouth. If the effort to do so fail, food should be given by the stomach-tube and by the rectum. Paralysis of the muscles of the palate, pharynx, and larynx, sometimes supervenes in diphtheria, so that milk and other fluids trickle out by the side of the tube, or enter the trachea and excite cough. Here, again, is an indication for using the stomach-tube and the enema-syringe.

The *care of the canula* is a point of gravest importance. As already mentioned, the tube is liable to become obstructed by expectorated products. If these are not removed, suffocation will ensue. Hence a competent attendant—by preference a judicious medical attendant, familiar with the character of the accidents which may follow tracheotomy—should be at the side of the patient, or within immediate call, until all danger from this source is over. Should the tube become occluded, relief must be immediate. Such occlusion is indicated by restlessness of the patient, and by peculiar moist sounds in respiration; the inner tube should then be removed for cleansing, and the outer tube should be swabbed out with a feather or a soft mop. These manipulations, as well as the replacement of the inner tube, usually excite cough and expectoration of occluding products. Partial or complete occlusion of the outer orifice with the finger, during the explosive movements of the cough, renders that act more effective. Soft, antiseptic sponges or mops should be at hand to catch any discharges which may present themselves externally, and to prevent their being sucked back into the canula. A shred of pseudo-membrane detained at the inner extremity of the tube, produces a characteristic flapping, at times attended with harsh and stridulous respiration; cough is excited, and the membrane is usually ejected after some effort. Should this expulsion be retarded, the inner tube should be removed; and if the membrane be not then driven through the outer one, attempts should be made to catch it with curved forceps. Should these fail, cough should be excited by passing a feather or delicate mop through the tube into the trachea. Should this too fail, a few minims of water should be passed, drop by drop, and the instillation be repeated at intervals of a few minutes. This failing, aspiration should be made with the catheter and syringe. If the obstruction resist all these measures, the outer canula should be removed, when the membrane will probably be coughed through the unobstructed orifice. The removal of the canula, especially during the first twenty-four hours, necessitates a skilled hand for its re-introduction. When it cannot be replaced, or when its presence prevents expulsion of obstructing products, some other method of keeping the orifice open must be employed. Here the dilating retractor of Golding-Bird will again be of great use. Hooks may be improvised from hair-pins, and may be held in position by tapes passing around the neck. Skilled judgment is necessary for the recognition of these important points, and for their proper management. An officious nurse may interfere unnecessarily on the one hand, and do injury on the other. The obstructed character of the respiration is the guide for interference. Under all circumstances, the condition of the inner canula should be observed every two or three hours, to clear it of any viscid secretions that may have adhered to it; and these should be carefully examined in water, so as to detect membranes, which will float out in flat pieces, their amount indicating how the case is progressing.

Changing the Canula.—At the end of twenty-four hours, or thereabouts, the canula, soiled as it is with blood and sputum, should be removed for cleansing, and be replaced by a clean one. It is best to do this by daylight, and with the child in the same position as when it was inserted. This removal is followed by cough and discharge of morbid products. The tube being removed, the parts are to be carefully inspected and carefully cleansed. If everything has gone on well, the tube, if of silver, though soiled by mucus, pus, and blood, will not be tarnished. If blackened, mortification is indicated at the corresponding point of the wound. If the tissues are healthy, the parts will be normal in color, and soft; and the edges of the wound will be everted. Sometimes the parts will be so pliable as to turn inward and occlude the tracheal incision. Then a dilator should be introduced to keep the wound open until a tube is inserted. Meanwhile, if indicated, search may be made for false membrane. The canula should be changed once a day, and the wound dressed if need be. When air begins to pass by the natural passage, as tested by covering the external wound with the finger-tip, the tube may be left out for a few minutes at each dressing, to be replaced immediately should respiration become embarrassed. From day to day the tube may be dispensed with for increasing intervals, until it is finally put aside. One of the most favorable indications for this procedure is expectoration by the mouth.

Definitive Removal of the Canula.—Usually practicable from the fifth to the ninth day, this may not be feasible for many weeks. Some series of observations are remarkable. Thus in a series of fifteen successful cases recorded by Max Müller,[1] the tube was not definitively removed in thirteen until the 13th, 15th, 25th, 27th, 44th, 45th, 51st, 69th, 70th, 105th, 112th, 120th, and 203d days respectively. In a series of eighteen cases recorded by Steiner,[2] the tube was removed on the 10th day in two cases, on the 17th in 1, 20th in 3, 21st in 2, 25th in 2, 28th in 4, 30th in 1, 35th in 1, and in the remaining cases not until the end of fifteen months. Sanne[3] gives a series of 108 cases, in 65 of which the tube was removed before the 9th day, and in one instance at the end of the first day; from the 9th to the 25th in 37 cases; from the 30th to the 45th, in 5 cases; and in 1 case on the 126th day.

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[1] Archiv für klin. Chirurgie, S. 448. 1871.

[2] Jahrbuch der Kinderheilkunde, No. 1. 1868.

[3] Étude sur le croup après la trachéotomie. Paris, 1869.

The causes preventing early, definitive withdrawal of the canula, are inflammatory tumefaction, spasm, and diphtheritic paralysis. Prolonged retention is, in most cases, due to fungous excrescences in the track of the wound, or on the internal surface of the air-passages. These are often the direct result of irritation by the edges of a fenestrum in the upper portion of the outer tube, so placed, in the great majority of instances, as to open upon the track of the fistula in the soft tissues exterior to the air-passages, instead of being wholly within the air-tube. Practically the fenestrum is useless, for no tube should be used large enough to fill the calibre of the air-passage, or to prevent a sufficient current of air from passing outside for purposes of phonation.

The canula having been removed, the remaining fistula should be allowed to contract of itself, the part being simply protected from access of dust by a little apron of muslin straddled on an adhesive strip, or a tape, above it. If undisturbed, the cicatrization is usually complete in two or three days, sometimes in less than forty-eight hours. When cicatrization progresses satisfactorily, the prognosis is favorable as to ultimate recovery. Delay indicates some impending complication, usually pneumonia, an exanthem, or paralysis.

The casualties which prevent recovery after tracheotomy for croup or diphtheria arise from two sources. Those of one set are incident to the disease, and those of the other to the operation. The first will be merely mentioned. They comprise extension of the pseudo-membrane, systemic infection, paralysis, nephritis, pneumonia, and heart-clot. The accidents of the second class comprise hemorrhage (primary and secondary), emphysema, inflammation of the track of the incision, erysipelas, abscess, gangrene, diphtheria of the wound, ulceration of the trachea, and pneumonia. Some of these need special comment.

Hemorrhage may result from division of a vessel during the operation, from manipulation in dressing the parts, from ulceration by pressure of the canula, or from vascularity of the delicate granulations in the track of the wound. Compression against the tube is the best treatment, small pieces of absorbent cotton being placed above the incision, one on top of another, as required. It is dangerous to remove the canula and search for the bleeding vessel. Alcohol and ergot may be administered internally. Inflammation of the wound and of the parts around it, occurs more frequently in tissues over which a fine gum cloth or piece of oiled silk has been used as a dressing, vesication taking place under the dressing in consequence of detention there of the secretions and discharges. Hence it may be avoided to some extent by rejecting such dressings. The swelling may be so great as to necessitate removal of the original tube and its replacement by a longer one, to reach the interior of the air-passage.

Emphysema is usually caused by an unskilful operation; most frequently by denudation of the peri-tracheal fascia in rough endeavors to introduce a tube; less frequently by faulty incisions. If limited to the vicinity of the wound, it is practically unimportant. If extensive—and it is sometimes very extensive—it may force the tube out of the trachea, and necessitate the substitution of a longer one. It usually disappears within a day or two. Occasionally it lasts more than a week. If due to the use of too short a tube, a longer one must be introduced, or a catheter substituted for it, the edges of the tracheal wound being kept asunder by dilator, forceps, blunt hooks, bent hair-pins, ligatures, or whatever device may be at hand. Much of the air in the vicinity of the wound can be expelled by gentle friction towards it. Sometimes it may be necessary to puncture the skin at a few points.

Ulceration of the trachea by attrition of the canula may be superficial, or may be so deep as to expose the cartilages or even penetrate the trachea. It is due to illy fitting tubes. It is most frequent anteriorly, sometimes occurs posteriorly only, and occasionally exists in both directions. The innominate artery has been known to be opened by ulceration of this kind. Frequent inspection of the canula will discover blood or tarnish at its extremity, if it is producing ulceration; while cough, and pain referred to one spot, will constitute the subjective indications. Change in the length and shape of the canula is the preventive remedy.

BRONCHOTOMY: LARYNGOTOMY, TRACHEOTOMY, ETC.

BRONCHOTOMY.—*Bronchotomy*, literally a division of the windpipe, is the generic term long applied to incisions made into any portion of the air-passages, although a wound of a bronchus has never been included in the category—the word *bronchus* having been used by the ancients to designate the trachea, and the word *bronchia* its ramifications.

As their names imply, *laryngotomy* and *tracheotomy* denote incisions into the larynx and into the trachea; and *laryngo-tracheotomy*, a continuous incision involving both structures. They are performed to secure artificial openings for several purposes, namely, the re-establishment of respiration when the normal channel is occluded above; the removal of foreign bodies, whether of pathological origin or of accidental introduction; and the extirpation or destruction of morbid growths. They are performed in the middle line, except when unusual conditions compel a lateral incision.[1]

Laryngectomy is an exsection of the larynx, whether partial or complete. It is sometimes associated, in either instance, with exsection of adjacent structures. It is occasionally performed in certain cases of irremediable malignant disease of the larynx, usually sarcoma or carcinoma. A limited partial laryngectomy, termed *resection of the larynx*, is sometimes performed in stricture of this part, to remove cicatricial and other indurated tissue.

Laryngotomy may be complete or partial. Complete laryngotomy implies section of the thyroid and cricoid cartilages and the intervening crico-thyroid membrane. It is rarely performed, and usually only in removals of extensive intra-laryngeal morbid growths, or as a step preliminary to possible laryngectomy. Section of the thyroid cartilage, *thyrotomy* or *thyroidotomy*, is usually performed for the purpose of removing morbid growths unsuitable for operations by the natural opening, and for gaining access to foreign bodies imprisoned in the upper portion of the larynx, especially when the intruders are caught in one or both ventricles. Section of the crico-thyroid membrane, *crico-thyroid laryngotomy*, *crico-thyrotomy*, or *intercrico-thyrotomy*—a meso-chondric operation—is usually performed in cases of occlusion of the upper portion of the larynx from acute disease, in which the artificial opening is needed but for a few hours, or a few days; or for access to minute morbid growths upon the vocal bands or beneath them. It is occasionally performed for access to a foreign body in the larynx. It is the operation until recently most generally known as laryngotomy. Being by far the easiest and least dangerous operation of the entire series, it is often performed upon a sudden and sharp emergency, or when the operator has no assistant at hand. It is rarely performed upon children for any purpose. When the opening which it gives is insufficient, it is customary to prolong the incision a slight distance into the thyroid cartilage, or to sever the cricoid cartilage.

Section of the thyro-hyoid ligament—*sub-hyoid pharyngotomy*, sometimes incorrectly called *sub-hyoid laryngotomy*—exposes the upper aperture of the larynx, especially if the epiglottis be drawn out through the wound. It is occasionally performed to extirpate a morbid growth, or to remove a foreign body. Sometimes it is performed in desperation in an emergency, when suffocation is imminent from inflammatory tumefaction or other obstruction at the top of the air-passage. It is the usual cut of the suicide. It accomplishes the main object of giving air to the lungs, but is not an operation of election.

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[1] Lateral incisions into the trachea were recommended by Quain (Elements of Anatomy. London, 1829; cited by Gross, op. cit., p. 234), and were practised several times for the extraction of foreign bodies by Gilbert, of Philadelphia (Am. Journ. Med. Sci., N. S. vol. xxi. p. 74, 1851).

TRACHEOTOMY, the chief operation of the series, is practised for the removal of foreign bodies from the air-passages; for giving air in inflammatory occlusions, acute or chronic, above the points of election; for croup and diphtheria; and as a prophylactic measure permitting temporary tamponning of the trachea during bloody operations upon the mouth and face. There are two points of election in tracheotomy, the one above the thyroid gland and the other below it. The choice is governed by the purpose for which the operation is to be performed. Incisions at these localities are known respectively as the high and the low operation. Sometimes the election cannot be made, and the incision must be made right through the gland. Although direct section of the gland is often done with impunity, the well-known vascularity of its structure naturally indicates the propriety of securing it between two ligatures before it is divided. The high operation is performed by most surgeons in cases of croup and diphtheria, as being the easier of execution, and the less liable to complication by hemorrhage. Nevertheless, from choice or habit, some operators, myself among them, almost invariably perform the low operation. The low operation, which permits the use of a tube of large calibre, is to be preferred in all instances of irremediable and other serious disease of the larynx, in which the artificial opening has to be kept patent permanently or for a long time; because the resulting wound is less liable to implication by extension of morbid processes. The same argument holds good, to a certain extent, even in diphtheria. The low incision is also to be preferred in case of impaction of a foreign body in a bronchus.

Tracheotomy is to be preferred to the meso-chondric operation, or to laryngotomy, in all cases in which a tube has to be worn for a long time; as it avoids interference with the functional exercise of the vocal bands on the one hand, and impairment of the solidity of the larynx on the other. So suddenly and urgently does the need for immediate tracheotomy occasionally present itself, that every practitioner should become sufficiently familiar with the details of the operation to be able to perform it in an emergency. Being the most important operation of the series of incisions into the air-passage, its description will embrace many features common to all. The special points of the remainder can be mentioned afterwards. Preceding this description, several considerations demand attention.

When, after prolonged dyspnœa from obstruction of the air-passage, that passage is opened by an incision, the sudden entrance of a large volume of air seems to surprise the lungs, as it were, and there ensues a *momentary arrest of respiration*, which may be mistaken for its cessation. Familiar as this becomes to the experienced operator, it is a surprise to the novice, and may fill him with dread lest he should lose his patient at the very moment of saving life.

The question of *anæsthesia* in these operations is an important one. Much as it facilitates the execution of the operation, my own opinion is that it should be avoided whenever practicable, epecially in the presence of great obstruction to breathing. With a few exceptions, it has not been used by myself for many years, even in children. Recovery is better when it has not been used, and imminent immediate dangers are avoided. It is often important to have consciousness retained, so that the patient can cough and expectorate voluntarily, or take a deep inspiration when so commanded. This advantage, which may avert death by suffocation, is lost when an anæsthetic is given.

Chloroform is preferable to ether, even in the adult, because it is less likely to induce vomiting, and thus possibly lead to inundation of the air-passages, and because it is less irritating to the mucous membrane. Ether, being inflammable, must not be used in operations by ordinary artificial light close at hand, nor in operations performed with the incandescent cautery. In children poisoned by carbonic acid from insufficient aëration of the blood, in croup and diphtheria, anæsthesia often exists to such an extent that the knife is not felt. In some instances, though the cut be felt, the infant budges but little; as if it appreciated the nature of the steps being taken for its relief. Should an anæsthetic be administered, it need be pushed no farther than the induction of unconsciousness, or the abolition of cutaneous sensibility.

When an anæsthetic is withheld from children, the limbs and trunk should be carefully secured in a large towel or a sheet, to control struggles which would embarrass the operator. Adults can usually be coaxed to go without an anæsthetic, especially when they are told that but little pain ensues after the skin has been cut, and that this part of the operation can be done in a second. The pain will be still less if the parts be frozen with ice and salt, or with spray of ether or of rhigolene; and this may be done sometimes, as a compromise. Union, however, is much more tardy when the tissues have been frozen.

The occasion is sometimes presented for immediate tracheotomy, though neither surgical instruments, nor appliances for keeping the wound patulous, be at hand. The trachea or the crico-thyroid membrane may then justifiably be penetrated by one thrust of pocket-knife or scissors, and the instrument may be turned around in the wound, so as to keep the edges apart until assistance can be had to complete arrangements for the patient's safety.

In performing these operations, the patient may be recumbent or semi-recumbent. The latter position is often preferable in the adult, especially when the dyspnœa is intense. Should the recumbent position be selected, the shoulders are to be elevated, and the head is to be allowed to hang back a little, supported by a firm, cylindrical compress, or cushion, under the neck, such as can be improvised by rolling a towel around a wine-bottle or rolling-pin. The object is to render the larynx and trachea sufficiently prominent to facilitate the steps of the operation, without forcing the head back so far as to embarrass respiration by compressing the trachea upon the vertebræ. Some operators stand at the head of the patient, and cut towards themselves; the advantages being a better view of the inferior portions of the wound, and less liability to have the blood and mucus spattered in the face. Others stand at the side of the patient, and cut from above downward. The advantage here is that the normal relations of parts are more easily kept in mind. In operating in the semi-recumbent position, which I prefer, because it approximates the position of the parts maintained by the invalid during the greater portion of his time, the head is bent gently backward over the top of the chair, and the chair is then tilted back a little and maintained in position by supports. The operator may stand at the head of the patient, but when the operation is likely to be a prolonged one, as in the extirpation of morbid growths, it will be better for him to kneel upon a cushion at the patient's side. A reflector is useful at times to facilitate illumination of obscure portions of the field of operation. Operations with the head thrown entirely back beyond the operating bed or table (Rose's method),[1] are sometimes performed to prevent blood from flowing down the air-passage. The head is to be supported in the two hands of an attendant, who kneels on a cushion in front of the operating table; the mouth must be kept open by a speculum or dilator, and the tongue be held up with blunt forceps so that it shall not cover the palate and thereby impede respiration. The operator takes a seat in front of the patient's head, and operates by reversed incisions.

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[1] Arch. f. klin. Chir., Bd. xvii. S. 454. 1874.

Unwarrantable dread of hemorrhage has led a number of practitioners to substitute the incandescent cautery for the knife in making their way down to the air-tube. Thus, some have used the potential cautery,[1] and others the electro-caustic knife,[2] the electro-caustic loop,[3] or the thermo-cautery.[4] Furthermore, Dujardin used a caustic paste,[5] Chassaignac employed the *écraseur*,[6] and Guérin proposed a subcutaneous tracheotomy.[7] On the other hand, so little dread of hemorrhage is felt by some operators, that they transfix the parts and plunge the knife into the windpipe, right through all the coverings, and divide all the tissues in a single cut; but fatal results sometimes follow this procedure. De Saint Germain claims to have performed tracheotomy by one movement in 227 cases, without a single grave accident due to the operation.[8] The late Dr. Krishaber, of Paris, informed me, that he regarded this operation as perfectly safe in children under five years of age, in whom he considered the vessels too small to present much danger. It seems to me, however, that in the very cases in which this procedure is most employed—cases of croup and diphtheria—the character of the wound would often prevent that proper search for false membrane which should precede the introduction of a canula, while the dilatation of the wound, necessary in case of accident to hunt for bleeding vessels, would render the entire operation much more serious than a deliberate dissection in the first instance. Similar objections present themselves to the instantaneous use of tracheotomes. Instantaneous tracheotomy, as practised by Chassaignac, Isambert, and others, is performed by fixing the trachea with a grooved tenaculum, secured directly beneath the cricoid cartilage, and then penetrating the windpipe by a direct puncture along the groove, through all the intervening tissue. Though often successful, the posterior wall of the trachea is sometimes severed in the incision. Krishaber employed a knife grooved along the back, so that the escape of air might advise him that its point was within the air-tube.

The following deliberate method of operating seems to me sufficiently rapid for most purposes. Under favorable conditions I have frequently completed the procedure within three minutes, but complications occasionally prolong the operation for half an hour or more.

The patient being placed in position, and his head being steadied by an assistant whose duty it must be to keep it strictly in the middle line, the operator takes his position at the right side of the patient, and the chief assistant at the left. Two methods are employed in making the preliminary incision through the skin and superficial fascia. In the one, the integument is held up in a transverse fold between the otherwise disengaged thumb and forefinger of the operator and his assistant, and is then divided by thrusting a bistoury through its base and cutting from below upward. In the other, which I think preferable, the integument is made tense by spreading the thumb and forefinger along each side of the trachea, and the incision is then made from above downward. The preliminary incision must be strictly in the middle line, as must be all subsequent incisions. If the hand is not to be trusted, this line of incision should be marked out with pencil or with ink. It should extend from the cricoid cartilage to within a third of an inch of the sternum, and will vary in length with the size of the patient and the swelling of the parts, from an inch and a quarter to two inches. In spare subjects one inch will often suffice. It is highly important that all subsequent incisions be made in the middle line likewise. For this reason the traction kept up on the soft parts should be slight, and equal on the two sides. In certain cases of external tumor, the incisions may have to be more or less to one side. Any wounded arteries having been secured, if necessary, the operator can expeditiously reach the trachea after the following manner, essentially as recommended by Langenbeck: With sharp-toothed forceps he seizes the connective tissue on one side of the middle line, while his assistant does the same thing on the other side. The two then raise the fold of fascia and the operator divides it with knife or scissors. Scissors are very useful for the purpose. In this way fold after fold is severed, large vessels being pushed aside or divided between double ligatures. Both ends of such ligatures should be cut off close, lest they should become detached during the further progress of the operation. The grooved director is preferred by many to forceps as a guide in dividing the layers of fascia. When the pairs of sterno-thyroid and sterno-hyoid muscles are reached, they must be carefully separated, and with as little use of the knife-blade as possible. This having been accomplished, the upper portion of the trachea is exposed, and is usually readily recognizable by its glistening surface.

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[1] Le Clerc, Revue Méd., 1861; cited by Kühn, in Günther's Lehre von den blutigen Operationen, Bd. v. Leipzig und Heidelberg, 1864.

[2] Verneuil, Bull. de l'Acad. de Méd., p. 299. 1872; Bull. de Thérap., p. 472. 1872; Voltolini, Berlin. klin. Woch., Bd. ix. S. 11; Lancet, 1872.

[3] Amussat, Arch. Gén. de Méd., Janv. 1873; Tillaux, Gaz. des Hôp., 1874.

[4] Krishaber, Annales des Maladies de l' Oreille, du Larynx, etc. Paris, 1876–7–8; Poinsot, Bull. de la Société de Chirurgie, t. iii. No. 6; Lancet, 1878.

[5] Kühn, op. cit.

[6] Med. Times and Gaz., 1872.

[7] Ibid.

[8] Gaz. des Hôp., 5 Janv. 1881; Medical Record, March 19, 1881, p. 319.

The isthmus of the thyroid gland, according to its size, covers more or less of this portion of the trachea. If the high incision is to be made, that structure is pulled downward. If the low incision is to be made, it is pushed upward. When these manipulations are insufficient, two strong threads are to be drawn tightly about it, on either side, so that it can be safely divided between them. This precaution is deemed superfluous by some operators, yet copious bleeding is not uncommon when the gland is cut through without it, and even when it is lacerated by tearing it apart. The field of operation is cleansed of blood from time to time in the usual manner. When necessary, the soft parts are kept asunder by blunt hooks on either side. The trachea having been exposed and fully recognized by its anatomical construction, should be freed anteriorly of its enveloping fascia for a space comprising rather more than that to be subjected to incision, and for a line or more in width, in order to avoid all risk of emphysema of the connective tissue by escape of air at the tracheal orifice. This may be done by scraping it with some blunt instrument or even with the blade of the knife. As soon as all bleeding is under control, and sooner if imperatively requisite to avert imminent danger of immediate suffocation, the trachea is to be divided for the space of three or four rings, by thrusting a bistoury vertically into its interior through an inter-cartilaginous space at the median line, and cutting from below upward, a procedure much more prudent than cutting from above downward. Should there be any difficulty in steadying the trachea, it may be held upward by a tenaculum thrust beneath the cricoid cartilage or one of the upper rings. Occasionally strong scissors, or even a saw, may be required to divide stoutly ossified cartilages. As soon as the trachea is penetrated, air escapes with a peculiar hiss, and blood and mucus are expelled by cough as the incision is completed. Sometimes the tracheal mucous membrane is so vascular that the hemorrhage is quite free. The operator now places a forefinger over the artificial opening, insinuating the finger nail into the incision.

He then seizes the edge of the trachea on the distant side with a pair of toothed forceps, closes the slide and hands it over to his assistant, and immediately secures the other edge with a similar instrument which he retains in his own grasp. The two now make slight traction, so as to lift the trachea and separate the edges of the wound, and the air enters without impediment. As already noted, a normal, momentary apnœa may be expected to follow the first deep inspiration. If false membrane or foreign body is to be searched for, the proper manipulations are then to be made. If a canula is to be introduced, the edges of the incision are held asunder sufficiently for the purpose. If the canula is to be worn for a long period, a small, semi-elliptic section should be dissected from each edge of the incision, so as to leave a permanent orifice and thus avoid undue injury to the cartilages by stretching them asunder. Long-continued retention of the canula is almost certain to cause necrotic destruction of the edges of the artificial aperture, and nothing is gained by omitting their exsection. When the canula is to be worn but a few days, as in operations for croup, œdema, etc., no such section should be made, as it impairs the integrity of the air-tube after cicatrization, and may lead to internal hernia from atmospheric pressure externally. Should some intra-tracheal operation be requisite, the incision can be kept patent by Golding-Bird's automatic retractor (see Fig. 1042, p. 676), or by some substitutive device.

Simple as tracheotomy is, in some individuals, in others it becomes quite difficult—often from complications presenting themselves as the operation progresses. This is especially the case in children. As bold and experienced a surgeon as Billroth[1] considers tracheotomy in children the most difficult operation that he has ever performed; an opinion which but echoes a similar expression by Gross.[2] What value then can be assigned to the experience of those who pronounce it "a very simple operation?" While many a tracheotomy is practicable without the necessity of securing a single bloodvessel, the plexus may be so extensive as to require many ligatures. Short necks, superabundance of fat, enlarged thyroid glands, and anomalous distribution of blood-supplies, present much need for cautious manipulation. In such instances, no hesitation should be felt in making as free an incision through the integument as may be desirable to secure proper illumination of the field and ample room for the fingers.

A "bloodless tracheotomy" has been urged by Bose,[3] to supersede the ordinary high operation. In this procedure, the first incision is a longitudinal one, extending from the median portion of the thyroid cartilage to about the fourth ring of the trachea. The cricoid cartilage being fully exposed, is then steadied with the finger, and a second incision, rather less than half an inch in length, is made transversely and as close as practicable to the upper margin of the cartilage. This incision, in which the main feature of the operation resides, divides the duplicature of fascia between the cricoid cartilage and the isthmus of the thyroid gland; the *fascia laryngo-thyreoidea* (Hueter). The lower border is seized with forceps, and the fascia stripped from the cricoid cartilage and the trachea with a blunt hook or a director—the isthmus of the gland being gradually loosened from its connections, and pushed downwards and outward, laying the rings bare. The directions of the lines of incision are shown in Fig. 1064.

In cases of emergency, with poor light and without skilled assistants, a rapid tracheotomy is thus executed by Durham.[4] The patient being put in proper position, a careful preliminary examination of the parts is rapidly made. The surgeon then places the forefinger of his left hand on the left side of the trachea, and the thumb on the right, and makes uniform, steady, deep pressure until he is able to feel the pulsation of both carotid arteries; and then the finger and thumb are slightly approximated so as to hold the trachea firmly and securely. The finger and thumb are not to be moved until the trachea is reached. As the surgeon cuts confidently down in the middle line by a series of careful incisions, the pressure upon the trachea causes that structure to advance and the wound to gape. When the trachea is reached, as indicated by the sensation imparted through the knife, or by examination from time to time with the forefinger of the right hand, it may be opened at once, or after having been secured with a sharp hook. In twenty-three cases in which this method has been adopted by Mr. Durham, that surgeon has had no reason to regret the course pursued.

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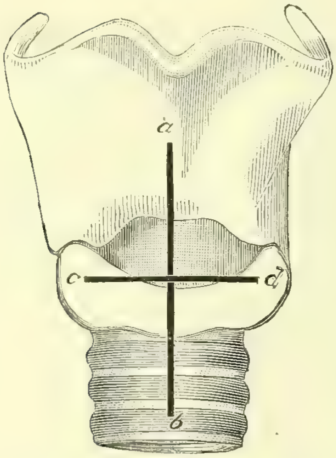
[1] Clinical Surgery, p. 140. London, 1881.

[2] Op. cit., p. 231.

[3] Archiv für klin. Chir., Bd. xiv. S. 137. 1871.

[4] Op. cit., 3d. ed., vol. i. p. 775.

Fig. 1064.



Lines of incision in Bose's method of tracheotomy. (Mackenzie.)

While it must be admitted that serious hemorrhage sometimes follows accidental or careless division of vessels unexpectedly found in the line of dissection, and occasionally with fatal results, it may be contended that the well-known frequency and variety of abnormal distribution of bloodvessels should insure sufficient care on the part of the operator to keep him on the lookout for vessels in the way of his knife, until the trachea has been prepared for the incision into it. The finger, as well as the eye, must be brought into frequent requisition, and when the direct light is poor, a reflector should be used to illuminate the parts. If dangerous vessels cannot be avoided, they should be secured in advance.[1]

In cases of excessive venous congestion, with threatening suffocation, in which time cannot be spared for securing vessels before or immediately after their division, it is sometimes necessary to complete the operation, despite the hemorrhage, so as to lay open the trachea, introducing the canula at once—when the bleeding may be expected to subside, as the re-establishment of respiration relieves the right chambers of the heart. Should normal respiration be delayed, artificial respiration must be instituted. The hemorrhage, however, does not invariably cease. The lesser of the two evils at hand, then, is to attempt completion of the operation, and give the patient a chance of resuscitation; the greater one is to delay, and let the patient suffocate beyond recovery.

Crico-thyroid Laryngotomy.—This operation presents little difficulty, the only tissues overlying the crico-thyroid membrane being skin and cervical fascia.

The patient being in the recumbent or semi-recumbent position, as circumstances may render desirable, and the position of the crico-thyroid membrane having been determined by palpation, the operator steadies the larynx between the thumb and fingers of one hand, at the same time making the skin tense, and then incises the integument and fascia longitudinally for the distance of an inch or an inch and a half in the median line, so that the middle third of the cut shall uncover the ligament. The ligament is then freed from any superimposed tissue undivided in the primary incision. The communicating branch of the two crico-thyroid arteries is now pushed aside, or secured by torsion, or ligatures if need be, and the ligament is divided by a transverse or a longitudinal cut as the case may demand. Should the opening be insufficient, a cross-cut is made. Some surgeons prefer an incision along the cricoid cartilage, others one along the thyroid cartilage. The latter procedure should be preceded by ligation of the two crico-thyroid arteries. In incising the ligament the knife-blade should be made to penetrate into the larynx, for the ligamentous structure retracts immediately upon section, and otherwise a second cut may become necessary to divide the mucous membrane.

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[1] For descriptions of the anomalies of vessels alluded to, the reader is referred to Tiedemann's Tabulæ Arteriarum; Breschet's Recherches Anatomiques, Physiologiques, et Pathologiques sur le Système Veineux; Gross's Foreign Bodies in the Air-passages; and Pilcher's Anatomy of the Anterior Median Region of the Neck (Annals of Anatomy and Surgery, April, 1881).

There is no risk of hemorrhage, save from the communicating branch of the two crico-thyroid arteries; but although usually slight, serious and even fatal bleeding from this source has been recorded.[1]

THYROID-LARYNGOTOMY.—Division of the thyroid cartilage is an operation much less difficult than tracheotomy. Care is to be exercised lest the vocal bands be unnecessarily wounded.

The patient being in position, and the assistants placed as in tracheotomy, the surgeon makes a median, longitudinal incision through skin and fascia, extending from the hyoid bone to just below the cricoid cartilage. Upon separating these tissues, it is well to look whether any exceptional, anomalous vessel crosses the field of operation, and if such be the case to secure it by torsion or by ligature. A sharp-pointed knife is now thrust, blade upward, through the crico-thyroid ligament just beneath the median line of the thyroid cartilage, and the latter is then divided by an upward, sawing incision. If preferred, a probe-pointed knife may be substituted for this purpose. In either case, the middle line must be strictly maintained to avoid wounding the vocal bands. The knife must be a strong one. I have used a pair of probe-pointed, angular scissors very satisfactorily, in this stage of the operation. When the cartilage is so ossified as to resist section with the knife, a stout pair of angular scissors, or even a pair of bone-scissors, may be necessary to effect the division. Krishaber and others prefer to effect the division of the cartilage from the outside, whether by successive strokes with the knife, or by means of a small saw, in cases of ossification. The great advantage is said to be avoidance of the coughing which often complicates division after penetration of the larynx. When divided, the two halves of the cartilage are to be separated by strong blunt hooks, or other retractors, so as to admit of whatever operation in the interior of the larynx may be required. An ingenious device of Dr. Cutter's[2] consists in two pairs of steel forks with the tines turned into blunt hooks, one of which can be placed above a vocal band on each side and one below it.

Should it be necessary to perform what Heine[3] has termed a resection of the larynx, the perichondrium is loosened with an elevator upon both sides of the two halves, as far as may be requisite, and the exposed cartilage is then removed with bone-pliers or saw, as may be required.

LARYNGO-TRACHEOTOMY is performed much more readily than tracheotomy, and is rarely attended with severe hemorrhage. It has long been thought that section of the cricoid cartilage, the main feature of the operation, seriously impairs the stability of the larynx; but the freedom with which this cartilage has been divided of late years, without any published evidence of permanent injury sustained thereby, appears to demand a reconsideration of opinion upon this point. This operation is not to be selected when a tube is to be worn for any length of time, as necrosis may ensue from pressure. Two fatal cases of necrosis of this cartilage have come under Durham's observation.[1]

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[1] Fergusson, System of Practical Surgery, p. 475. Philadelphia, 1853.

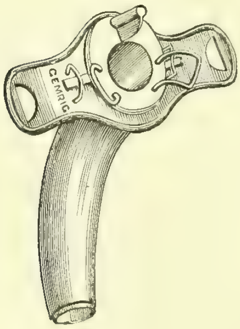
[2] Am. Jour. Med. Sci., January, 1867.

[3] Arch. f. klin. Chir., Bd. xix. S. 51.

The incision into the air-passage passes through the crico-thyroid membrane, the cricoid cartilage, the crico-tracheal membrane, and one or more rings of the trachea. The primary incision through the integuments is made a little higher up than for tracheotomy, commencing at the lower portion of the thyroid cartilage. The incision into the air-passage should be made from below upward to avoid wounding the isthmus of the thyroid gland. Even when the operation is an extension of an insufficient laryngotomy, it is better to cut from below upward into the first incision, than to extend the latter downward.

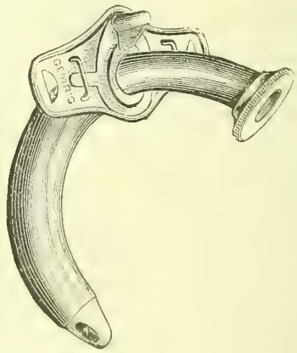
The Tracheal Canula.—In many cases, an artificial aperture into the air-passage must be kept open. The edges of the incision would soon unite were not some contrivance introduced to prevent this. A tube keeps the edges asunder, and permits ingress and egress of air for respiration. As mucus and other products might accumulate in sufficient quantity to clog the tube, it is customary to employ two tubes, as suggested by George Martin,[2] one fitting closely within the other, and projecting a little beyond it. (Fig. 1065.)

Fig. 1065.



Trousseau's double tracheotomy tube.

Fig. 1066.



Cohen's tracheotomy tube, with hollow conductor.

Should clogging occur, the inner tube is removed without disturbing the tissues at all, and is replaced when cleansed. The outer tube is made movable in a collar secured to the neck by tapes, and in this way it follows the movements of the neck with very little restriction. To facilitate the introduction of the tube it is well to run a catheter into it, so that the blunt end shall serve as a pilot. The tubes used by myself, an improvement upon those of Krishaber,[1] are provided with a metallic catheter-conductor, the external extremity of which—the handle—curves downward, and gives exit in that direction to any blood or mucus which may be ejected by cough on its introduction. (Fig. 1066.) When the tube is in position, the pilot is withdrawn and replaced by the ordinary inner canula. A silver tube is preferable to one of hard rubber, because it encroaches less upon the space for air, and because by tarnishing it will indicate at what point, if at any, mortification has taken place. Tubes should not be used for long periods without occasional careful inspection, as they are liable to corrosion, and may then drop into the air-passage. The tube should be of equal calibre throughout. When smaller at the inner extremity, as are most of the tubes in use, the patient will get much less air than he is supposed to do, judging from the size of the external orifice.

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[1] Op. cit., vol. i. p. 773.

[2] Van Swieten's Commentaries, vol. xi. p. 528; Philosophical Transactions, 1737.

The tube in general use has the form of the quadrant of a circle, which admits of the easy introduction of an inner tube; and the distal extremity is bevelled off so that it shall look downward instead of forward, and thus be much less likely to strike upon the anterior wall of the trachea. Much has been written about the shape of the tube. In the tracheotomies performed by myself, the quarter-circle tubes have been used almost invariably, and there has been no case of ulceration of the trachea to deplore. When evidences of abrasion have occurred, as noted by bloody stains upon the tube, the position of this can be altered by placing a compress underneath the neck-plate, thus relieving the tracheal wall from attrition. It is well to provide the patient with an additional tube, considerably shorter than the other, and to use the two on alternate days, so as to give the points of pressure alternate days of freedom. It has been a matter of observation that the track of the artificial passage through the soft tissues often becomes oblique in such a direction as to maintain the terminal extremity of a quarter-circle tube in the centre of the trachea. The calibre of the tube should be as great as is consistent with its easy introduction without touching the walls of the windpipe: six, eight, ten, and twelve millimetres in diameter, respectively, will, save in rare, exceptional instances, meet the requirements from infancy to maturity. Its length should be sufficient to insure it from being coughed out of the aperture

Fig. 1067.

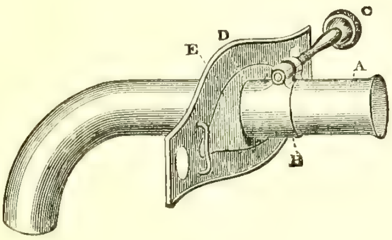
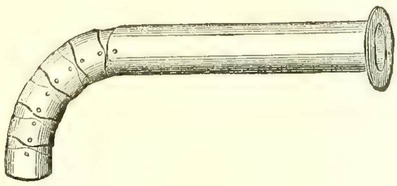


Fig. 1068.



Durham's tracheotomy tube and inner canula.

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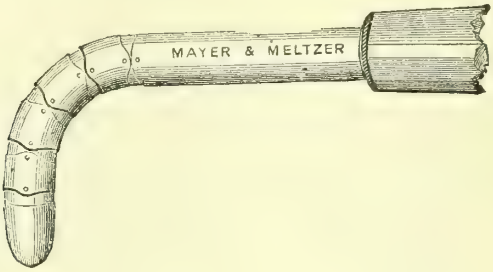
[1] Annales des Maladies de l'Oreille, du Larynx, etc., Juillet, 1878, p. 142.

in the trachea. Erosions of the trachea are sometimes produced by ill-fitting tubes, and fungous granulations are not infrequent at the site of the erosions. To avoid these accidents, Mr. Durham has devised a tube so curved that the two extremities occupy rectangular planes,[1] the horizontal portion being movable in a collar attached to the sheath, so that it can be set at the most favorable point to permit the vertical portion to rest in the very centre of the trachea, and thus avoid attrition against its walls. (Figs. 1067, 1068.) As a rigid tube cannot be introduced within the outer one, the distal portion of the inner canula is articulated in lobster-tailed links. The piloting guide or trocar (Fig. 1069) has the same construction. These joints soon stiffen with mucus, which renders it difficult, and at times impossible, to remove the inner canula while the outer one remains *in situ*. Hence additional care is requisite to withdraw the inner canula at intervals sufficiently frequent to avoid this occurrence. Theoretically, this form of tube demands the maintenance of a horizontal track through the soft tissues into the trachea. Should this track become oblique by the weight of the tube, as certainly does happen in some instances, the very evil would be produced for the avoidance of which it was devised. Soft-rubber, single tubes have been recommended by Mr. Morrant Baker[2] for use after the first few days, as being more comfortable; they are open to the same objections as all other single tubes.

Fig. 1069.



Durham's piloting trocar.

Whatever form of canula is used, it sometimes happens that difficulty is experienced in its introduction. When a conical conductor is not used, the edges of the incision may be held asunder by a tenaculum or blunt hook on each side, and the canula may be passed between them. The dilators already described are often used for this purpose. The introduction may be facilitated in many instances by holding the body of the canula transversely until the extremity has been passed into the trachea, and turning it downward as it is pushed further on. It is customary to warm the canula and to grease it before it is introduced into the artificial orifice. It thus enters more readily and excites less cough. Tapes are usually sewed to the slits or rings in the neck-piece, but buttons and button-holes render the tapes fully as secure as stitches, and permit their removal and renewal without disturbing the canula. One tape should be much longer than the other, so that the two can be tied at the side of the neck instead of at the nape, a plan much the more convenient.

To occlude the space between the canula and the trachea, and thus prevent the descent of blood in operations about the nose, mouth, pharynx, and larynx, Trendelenburg[1] has devised an elastic tampon-canula; the tracheal portion of the tube is encircled by an India-rubber jacket, into which air is forced from the exterior through a small tube along the side of the instrument. This has been improved by Semon,[2] who has adapted the device to the Durham canula, concealing the supply-tube in the interior of the instrument (Fig. 1070), and thus facilitating its introduction. Care is requisite in inflating the tampon, as sudden, excessive pressure may excite an asthmatic paroxysm.[3] Fresh rubber may have to be stretched over the canula each time that it is used.

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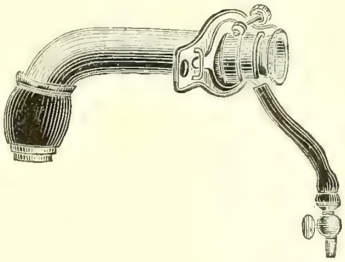
[1] Practitioner, April, 1869, p. 212.

[2] Med.-Chir. Trans., vol. lx. p. 71.

Fig. 1070.



Semon's tampon-canula. (Mackenzie.)

After-treatment of Tracheotomy, etc.—More or less paroxysmal cough usually follows the introduction of the canula, but this generally subsides after a few minutes. Sometimes it is very slight indeed. The edges of the cutaneous wound above and below the canula may be united by sutures, or may be approximated by adhesive strips. A plan pursued by Dr. Packard, of Philadelphia, consists in fastening a longitudinal strip of perforated plaster on each side of the incision, and passing threads through a few of the projecting perforations, then lacing the threads together so that the edges of the wound are not disturbed at all. According to my own experience, the wounds do best without any dressing beneath the neck-piece of the canula. The air of the room should be kept moist, and a thin section of moistened sponge may be placed over the orifice of the tube, and be changed from time to time. The secretions become so dry, unless some such precaution is taken, that the tube is liable to become clogged with thick, desiccated crusts. It is to effect their ready riddance that a double canula is used, the inner one being removed and cleansed whenever respiration appears obstructed. When the disposition to the accumulation of these masses has ceased, a layer or two of moistened muslin-gauze may be substituted for the sponge. This is kept warm by the expiratory current of respiration, and thus the temperature of the inspiratory current is somewhat modified in cool weather. The patient should be continuously watched for twenty-four hours or more, so as to insure prompt attention to the tube. Bronchitis and broncho-pneumonia sometimes follow any operation upon the air-tube, and attention is requisite for several days to detect their initial symptoms. Should the patient desire to speak, it will be necessary for him or his attendant to occlude the external orifice of the tube with the finger, so that the expiratory current of air shall pass by the side of the tube, and thus set the vocal bands in vibration. As long as the air escapes by the tube there will be no voice, except in occasional instances of very capacious trachea.[4] Patients who are compelled to wear the tube permanently are sometimes supplied with a special inner speaking-tube, provided with a valve at the external orifice which admits the passage of the inspiratory, and prevents the passage of the expiratory current. The instrument of Luer (Fig. 1071), which is one of the best, has a curved, adjustable chamber, in which a light, hollow, silver ball falls forward by gravity during expiration, and is rolled backward against a pair of wires during inspiration. When skilfully made, the valve makes so little noise as rarely to attract attention. The use of the valve-tube often diminishes hypersecretion very materially, to the great comfort of the patient. At night, and at other times when not required for purposes of conversation, the valve should be removed, as it impedes, to some extent, the freedom of respiration. A patient upon whom I operated in 1876 has worn this appliance with great satisfaction for eight years.

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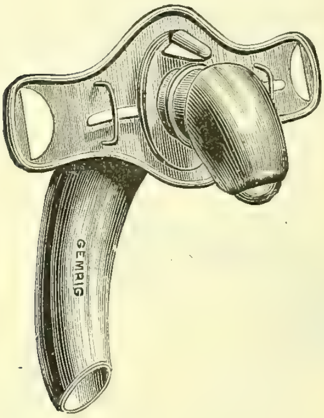
[1] Berliner klin. Woch., No. 19, 1871.
[2] Monatsschrift für Ohrenheilkunde u. s. w., No. 6, 1879.
[3] Mackenzie, op. cit. (Am. ed.), vol. i. p. 378.
[4] Cohen, Medical and Surgical Reporter, March 9, 1878.

Fig. 1071.



Luer's pea-valve tracheotomy-tube.

When the time comes for permanent removal of the canula, the external orifice should be corked from time to time, to learn whether the patient can get enough air by the natural passages. A fenestrated canula is not necessary for the purpose, as it is improper to use an instrument so large that an ample supply cannot pass by its sides. If a fenestrated canula be used, care must be taken that the opening is entirely beyond the track of the wound, as otherwise its edges will be apt to excite inflammation, which will be followed by the development of fungous granulations.

It must be borne in mind, that a number of accidental complications may occur during tracheotomy, or after it, some of which may cost the patient his life. Most of them are due to carelessness or negligence. Some take place despite every precaution. The posterior wall of the trachea may be penetrated, and a canula may even be passed right through it, into the œsophagus; the canula may be passed into the connective tissue in front of the trachea; there may be emphysema into the surrounding connective tissue, or perichondritis, chondritis, and necrosis; or there may be diffuse suppuration, fungous granulations, ulceration of the trachea penetrating even into the great arteries, stricture, or fistula. A knowledge that such things do occur should insure proper supervision of the wound, canula, and windpipe, until all danger of the sort has become a matter of the past.

Morbid Growths of the Larynx.

Morbid growths rarely involve the skeleton of the larynx primarily. Sometimes they are developed on the exterior surface of the organ, but they occur much the most frequently in its interior. Occasionally they are both intra-laryngeal and extra-laryngeal. The greater number by far are benign. Of the remainder, some are originally malign, while others become so secondarily.

Benign Growths.—While seventy cases of laryngeal morbid growth would most likely include the entire ante-laryngoscopic record, they have been reported to the number of thousands during the last twenty-five years. They are less common in America than they appear to be in Europe. Their etiology is still obscure. Usually referred to "colds" as the starting point, they appear due to local irritation during inflammations of the larynx, whether idiopathic, deuteropathic, or traumatic. Thus they follow simple laryngitis and, to a less extent, syphilitic and tuberculous laryngitis; the laryngitis of the exanthemata, measles especially; that of whooping-cough, croup, and diphtheria; that caused by inhalations of irritating matters; and that produced by local injuries. They are much more frequently single than multiple. The anterior portions of the larynx are the seat of morbid growths much more frequently than the posterior. Males suffer in far greater numbers than females. Some growths are congenital. Children acquire them at all ages; adults chiefly between the third and fifth decennia. My own experience includes their apparent development at the extremes of earliest infancy and the ninth decennium.

Fully two-thirds of all recorded cases of laryngeal neoplasm, are reported as papillomata. Of 100 cases of benign growth submitted to treatment by Mackenzie,[1] 67 were so considered; of 66 consecutive cases of growth of all kinds reported from my own practice,[2] 48 were known or inferred to be papillomata. Fauvel[3] reported 206 out of a total of 300. Most other observers of large experience present analogous results. Elsberg,[4] however, reports but 163 papillomata out of 310 morbid growths. The varieties of benign morbid growth, reported as having been detected in the larynx, include papilloma, fibroma, myxoma, adenoma, lymphoma, angeioma, cystoma, lipoma, and ecchondroma. Some growths are composite. Fatty, colloid, and amyloid degenerations have been noted in some instances. Papillomata are usually sessile, and frequently multiple. Other neoplasms are usually single. The size of laryngeal neoplasms varies from that of small seeds to that of masses large enough to occlude the larynx and project above it. While they may occupy any portion of the larynx, they have been noted with greatest frequency upon the vocal bands. This may be partly due to the existence of the vascular papillæ discovered on the edges of these bands by Coyne,[5] and partly a result of the vascularity maintained by their active movements in phonation.

Symptoms.—The general symptoms, much alike whatever the histological elements of the neoplasm, depend chiefly on its location, size, and character of attachment. Some growths do not give rise to any special symptoms. When located upon an important structure, when comparatively large, and when attached by a pedicle, they produce impairment of voice, impediment to respiration, difficulty of swallowing, cough, and pain. *Dysphonia* occurs only upon mechanical interference with due vibrations of the vocal bands. Thus, a fair voice may be maintained when a large growth is some distance from these structures, while hoarseness may be produced by a very small one upon them, beneath them, or between them, and intermittent hoarseness by a pedunculated growth, which interferes occasionally, or at frequent intervals, the voice failing and recovering itself several times, perhaps, during the enunciation of a single sentence. The alteration in voice may be limited to a certain portion of the register, when the growth occupies an acoustic node, and double voice, *diphthonia*, may result from symmetrical growths on the two bands, dividing the chink of the glottis into two portions. *Aphonia*, or absolute loss of voice, does not occur unless actual closure of the glottis has become impracticable. The voice during conversation is often unequal, or by turns hoarse, shrill, or muffled. It usually presents a peculiar dull quality, suggestive of a mechanical origin of the impairment, and unlike hoarseness and loss of voice from other causes. A characteristic "staccato" style of utterance, due to frequent inspiratory breaks, is often noticed with tumors that encroach much upon the glottis. *Dyspnœa* occurs only when the growth is large enough to obstruct respiration, or during intercurrent inflammatory swelling of parts adjacent. Indeed, such tolerance is acquired during the slow development of growths, that the lack of dyspnœa, sometimes compatible with very large neoplasms, is otherwise unaccountable. The dyspnœa varies with the size, location, and mobility of the growth. It may be extremely slight, except on exertion. It may be severe enough to threaten apnœa. It may exhibit any intensity between these extremes. Impaction of a neoplasm may suddenly produce suffocative apnœa, several fatal examples of which have been recorded by myself.[1] In some instances, usually indicative of a mobile growth, the dyspnœa is diminished by holding the head in a special manner. *Dysphagia* seldom occurs, unless the tumor occupies the epiglottis, an arytenoid or supra-arytenoid cartilage, or some portion of the pharyngeal surface of the larynx. Other things being equal, the dysphagia is generally proportionate to the size of the growth, although extreme difficulty of swallowing occasionally attends growths of insignificant volume. Regurgitation of food into the larynx sometimes takes place, and produces suffocative paroxysms. *Cough* is not a frequent symptom, unless the growth interest or tickle the vocal bands, whether by its size, its location, or its mobility. Vascular growths bleed sometimes, and excite cough. The character of the cough varies with the nature of the growth and the intercurrent laryngitis: it may be dry and hacking, or moist; it may be sonorous, hoarse, muffled, or toneless, according as the vocal bands are inflamed or impeded in their movements. With growths of large size the cough is sometimes brassy, like the cough of croup and of acute laryngitis. There may be no expectoration, or there may be expectoration of mucus, or of mucus and blood. Sometimes portions of a growth are detached in coughing, and expectorated; occasionally a growth is expectorated entire. *Pain* is infrequent, and usually attributable to intercurrent causes. Considerable aching in the parts is not infrequent. Sometimes the sensation is that of a foreign body that the patient tries to cough out. Severe paroxysms of pain occur in occasional instances. Epileptic seizures may supervene[2] in susceptible subjects, as they do in other diseases of the larynx. Growths of unusual bulk occasionally produce some alteration in the contour of the larynx perceptible upon palpation.

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[1] Essay on Growths in the Larynx. London, 1871.

[2] Diseases of the Throat, p. 415. New York, 1872.

[3] Traité Pratique des Maladies du Larynx, p. 190. Paris, 1876.

[4] Archives of Laryngology, p. 1. 1880.

[5] Recherches sur l'Anatomie de la Muqueuse Laryngée, p. 21. Paris, 1874.

Diagnosis.—This must be relegated to laryngoscopy. Palpation through the mouth may sometimes succeed in detecting an intra-laryngeal neoplasm, and more frequently an extra-laryngeal one; but the result is unsatisfactory even when the growth is large and quite high up. With children upon whom laryngoscopy may be impracticable, palpation may be the only available method of objective diagnosis; and it may be mentioned in passing that, under such circumstances, the opportunity should not be neglected, circumstances favoring it, to make an effort to dig the growth out with the finger, or to detach some portion of it. The mere detection of a growth laryngoscopically does not always complete the diagnosis as to its seat, location, size, and mobility. It is sometimes necessary to determine these points, important as guides to treatment, by palpation with a curved sound or flexible bougie manipulated under laryngoscopic inspection. The histological character of the growth cannot be accurately determined laryngoscopically; but certain general physical conditions about to be mentioned, are sufficiently characteristic to justify a probably correct inference. Portions of a growth may be removed for closer examination, but even then, there is sometimes uncertainty as to the question of composite structure.

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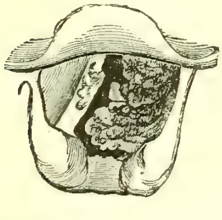
[1] Op. cit. p. 540.

[2] Sommerbrodt, Berliner klinische Wochenschrift, 25 Sept. 1876.

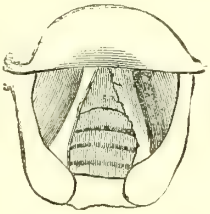
Papillomata (Figs. 1072 and 1073) are often multiple, usually sessile, more or less dendritic, and sometimes racemose. Their color varies from the merest tinge of red to an intense red. Some are quite white. Their size varies from that of small seeds to that of mulberries, or a series of mulberries. Sometimes they seem to fill the upper cavity of the larynx. They usually occupy the anterior portion of the larynx, and their most frequent seat seems to be a vocal band.

Fig. 1072.



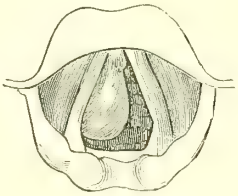
Multiple papillomata of the larynx.

Fig. 1073.



Larynx after their removal.

Fig. 1074.



Laryngeal fibroma.

Fibromata (Fig. 1074) are usually single,[1] smooth, and pendunculated. The pedicle is sometimes attached vertically, sometimes transversely. Most fibromata are red. Some are white or gray. Some of them are vascular on the surface. They are more uniform in size than the papillomata, and slower in development. Their size varies from that of a small pea to that of quite a large nut. They are most frequent on the vocal band.

Myxomata, which are quite rare, are usually single,[2] smooth, or slightly irregular in form, and pedunculated. They are pink or red, and their size varies from that of small seeds to that of large beans. They are most frequent at the commissure of the vocal bands.

Angeiomata (Fig. 1075), of which I have seen but four examples in my own practice, are usually single, reddish or bluish-black, of size varying from that of small peas to that of mulberries, and most frequent upon the vocal bands. Wagner[3] has reported one in a ventricle, and Mackenzie one in the pyriform sinus.[4]

Lipomata, of which I have not seen any example, may be so large as nearly to fill the larynx.[5] In V. von Bruns's case, the growth was sessile, lobulated, elastic, red, and located on the left arytenoid cartilage.

Cystomata are usually sessile, globular, translucent, and white or red. They occupy a vocal band occasionally (Fig. 1076), but a ventricle or the epiglottis more frequently. In a case observed in my own clinic, a cyst was seen to occupy both a ventricle and the glosso-epiglottic sinus.

Ecchondromata, unlike other benign growths, seem to be developed chiefly in the posterior portions of the larynx. Thus Stoerk[6] reports a case of large ecchondroma developed from the base of the left arytenoid cartilage;

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[1] A case of multiple fibromata (six) has been reported by myself. Medical Record, p. 265. 1869.

[2] A case of multiple myxomata (three) has been reported by myself. Transactions of the Pathological Society of Philadelphia, p. 151. 1873.

[3] Archives of Laryngology, p. 332. 1880.

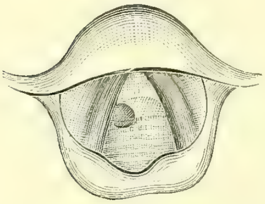
[4] Essay on Growths in the Larynx, Plate II. Fig. 12.

[5] V. von Bruns, Dreiundzwanzig neue Beobachtungen von Polypen des Kehlkopfes, S. 84. Tübingen, 1868.

[6] Op. cit., S. 417.

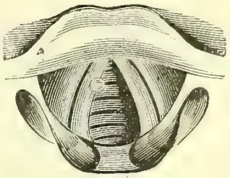
Ehrendorfer,[1] one growing inwards from the back of the cricoid cartilage; Musser,[2] one the size of a walnut projecting into the interior from the laryngeal face of the posterior portion of the cricoid cartilage; and Asch,[3] one springing forwards and inwards from the inner surface of the thyroid cartilage, apparently at the base of the superior cornu of the right side. The presence of a firm neoplasm, then, in the posterior portion of the larynx, should suggest a possible ecchondroma. When denuded of its mucous membrane, the glistening of the tumor through the rent adds additional probability to the diagnosis. Hardness on palpation is insufficient for differentiation from fibroma.

Fig. 1075.



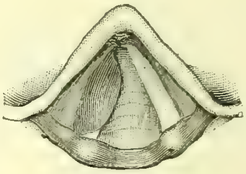
Angeioma on vocal band.

Fig. 1076.



Cystoma.

Fig. 1077.



Prolapsus of laryngeal sac.

The other benign growths do not seem to present characteristics sufficient for diagnosis by inspection.

Care is requisite to distinguish morbid growths from prolapsus of the laryngeal sac (Fig. 1077), of which a few examples are on record;[4] from gummata; from exuberant granulations about ulcerated surfaces; and from mere wrinkling of the mucous membrane in movement.

Prolapsus of a laryngeal sac can sometimes be differentiated by replacing the mucous membrane by means of a probe. By mere inspection, the differentiation would depend on the absence of all indication of a ventricle along the line of the tumor.

Prognosis.—The prognosis is generally favorable, provided that the morbid growth is detected, and that proper surgical treatment is instituted. Should proper treatment be declined, neglected, or delayed, death by sudden suffocation may ensue, in cases in which the tumor actually occludes the chink of the glottis, or is liable to become impacted in it. This danger of suffocation lends clinical malignancy to formations histologically benign. Restoration of normal voice, or of practically normal voice, usually follows the removal of neoplasms from the vocal bands, unless these structures suffer injury. Permanent impairment of the voice is a frequent sequel of the division of the thyroid cartilage, sometimes practised to get direct access to intra-laryngeal growths; not as a result of the removal of the growth, but in consequence of cicatricial adhesion at the commissure of the vocal bands. Recurrence of morbid growth should be less frequent after removal by direct access, yet statistics seem to show that it is less liable to follow removal through the mouth.[5] Recurrences are almost limited to sessile papillomata, and are often outgrowths from remnants of ill-extirpated growths, inefficiently cauterized. Some so-called recurrences are developments in new sites, and in no way associated with the original neoplasm. Papillomas are sometimes tortured into malignancy by irritation attributable to numerous unsuccessful attempts at evulsion, and occasionally by irritation from harassing cough and local friction. Fibromas and adenomas occasionally undergo malignant transformation. Growths unoperated upon, and growths subjected to inefficient, meddlesome interference, sometimes undergo suppurative inflammation, with development of an abscess which usually points externally, whether through the crico-thyroid membrane, or directly through the intermediate thyroid cartilage. The spontaneous or operative discharge of the contents of the abscess is sometimes followed by fistula. Some growths, probably merely local thickenings of tissue, occasionally undergo spontaneous absorption; and veritable neoplasms sometimes undergo spontaneous detachment.

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[1] Wiener med. Woch., 2 Juli, 1881; London Med. Record, Feb. 15, 1882, p. 65.

[2] Phila. Med. Times, May 6, 1882.

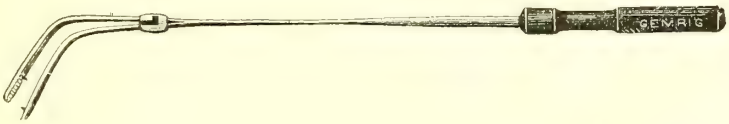
[3] New York Med. Journal, Aug. 30, 1884, p. 235.

[4] Moxon, Trans. Path. Soc. Lond., p. 65. 1868; Mackenzie, op. cit., p. 34; Lefferts, Medical Record, June 3, 1876; Elsberg, Archives of Laryngology, January, 1882, p. 67; Cohen, ibid., p. 66; Arnold, Medical News, May 5, 1883, p. 512.

[5] Bruns, Die Laryngotomie zur Entfernung intralaryngealen Neubildungen, S. 148. Berlin, 1878. For a contrary opinion, see Browne, The Throat and its Diseases, p. 251. London, 1878.

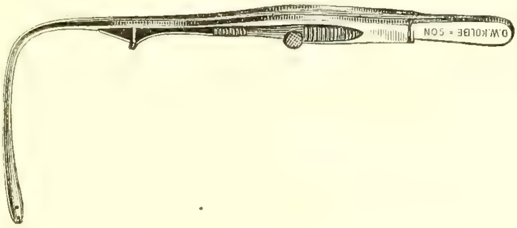
Treatment of Benign Laryngeal Growths.—Small growths, offering no impediment to respiration, present no indication for surgical interference, save when they impair the voice of an individual dependent upon its use for a livelihood. In other instances, slight hoarseness can readily be tolerated; and the indication for intervention remains optional unless the growth undergoes enlargement, when prompt measures for its removal become advisable. Small growths often remain stationary for long series of years. Medical treatment may be dismissed as useless, except in syphilitic subjects in whom condylomata or gummata may be mistaken for neoplasms. Even in the case of tuberculous granulomata, surgical treatment is often indispensable.

Fig. 1078.



Fexible sponge-holder with bayonet-catch.

Fig. 1079.



Cohen's rigid sponge-holder with lateral slide-catch.

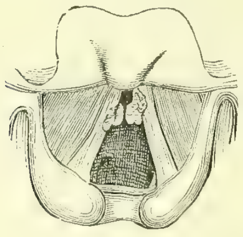
Two methods of surgical treatment are in vogue: one by way of the natural passage, principally or practically under laryngoscopic guidance; the other by direct attack, after external incision into the larynx.

Intra-laryngeal procedures comprise chemical or thermic cauterization, incision, abscission, crushing compression, and evulsion.

Cauterization.—Small, soft papillomata, favorably located, may sometimes be destroyed by repeated applications of concentrated solutions of zinc-chloride, silver-nitrate, or chromic acid, or by applications of nitric acid, acid solution of mercuric nitrate, Vienna or London pastes, or the electric cautery. To avoid unpleasant accidents, preliminary, tentative efforts are necessary, in order that the requisite steadiness of the patient, and that accurate manipulation by the surgeon, may be assured. Concentrated caustic solutions are best applied by means of small fragments of sponge, firmly secured in reliable forceps. (Figs. 1078, 1079.)

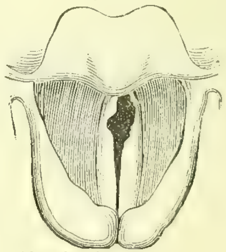
Solid caustics—silver nitrate and chromic acid—are best applied molten upon the roughened extremity of an aluminum probe. Concealed-caustic holders are clumsy to manage, and misguiding as to accuracy in manipulation. With tact and practice, the uncovered caustic can be applied thoroughly, and with equal safety. Repeated applications, at intervals of a day or longer, are usually requisite. The best chemical caustic, in most instances, is chromic acid. Its admirable effect is delineated in Figs. 1080 and 1081.

Fig. 1080.



Growths on both vocal bands.

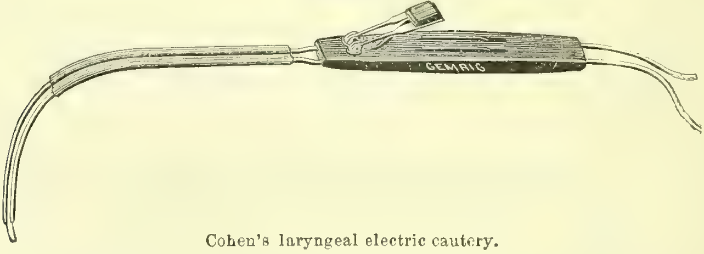
Fig. 1081.



Appearance of bands after destruction of growth by chromic acid.

Treatment by silver-nitrate is much more protracted. The electric cautery (Figs. 1082 and 1083) is preferred by many laryngologists, but is not in much favor with surgeons. Electric cauterization, while neither as painless nor as bloodless a procedure as has been asserted, is more liable than other methods of cauterization to excite acute traumatic laryngitis, and to be followed by secondary hemorrhage on detachment of the eschar. Whether a broad cautery or a pointed one is to be used, will depend upon individual indications. The shape of the largyneal curve can be readily altered by bending the conducting wires. Löwenberg, of Paris, has simplified this method of treatment by wrapping the insulating threads in such a manner as to leave exposed merely the segment of terminal to be pressed against the growth. In this manner the sound tissues are better protected. As a rule, collateral inflammation is greater after electric than after chemical cauterization. Neither method is desirable if the growth can be removed with

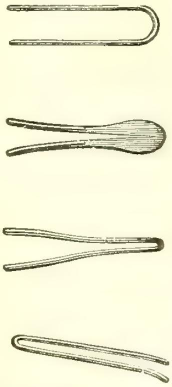
Fig. 1082.



Cohen's laryngeal electric cautery.

forceps. Either may be employed to destroy remnants of growths removed by other procedures. Either is applicable in case of small growths, too small to be caught in the grasp of forceps. The caustic must be retained in contact with the growth for at least two seconds. Momentary contact merely scorches the mucous membrane, and is liable to excite additional hyperplasia. The cauterizations are to be repeated at intervals of two days or more, according to the results. Immediate inflammatory effects may be moderated by sucking ice for a time. Suffocative spasm follows the first manipulations, but becomes more and more controllable thereafter. Voluntary, prolonged expiration is the best controller of such spasm, which usually relaxes with the deep inspiration succeeding. Intense spasm usually yields readily to the inhalation of amyl-nitrite. The posterior portion of the larynx is far more susceptible than the anterior. Fortunately, the growths under consideration usually occupy the anterior portion. Fortunately, too, the growth is rarely sensitive, however sensitive the surrounding structures. The tissues must be gradually inured to bear caustic applications. Life has been sacrificed by neglect of this precaution. The procedure may be regarded as safe, however, in discreet hands. Various methods have been recommended for producing local anæsthesia to avoid spasm, systemic anæsthesia being unsuitable to intra-laryngeal surgery. None are wholly satisfactory, and some are actually dangerous. It is far preferable to accustom the parts to the contact of probes and forceps, and thus induce a tolerance to more active measures.

Fig. 1083.

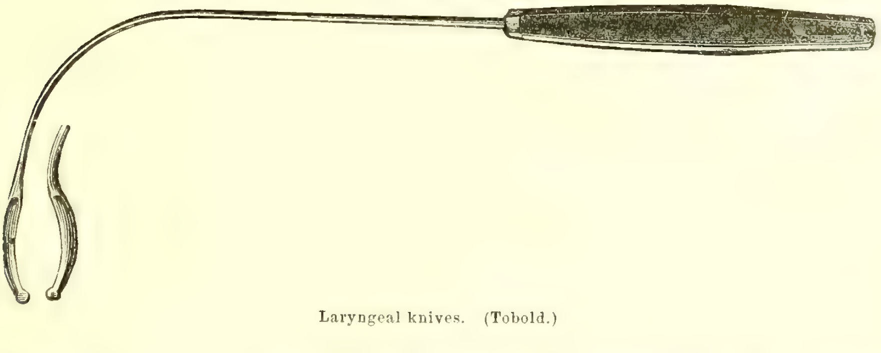


Cautery terminals. (Bruns.)

Incision is performed with knife blades, attached to properly curved rods. To meet the various indications, the blades must present their cutting edges in the proper directions (Fig. 1084). In skilled hands, naked instruments are better than concealed ones; but the method of incision is so little in use and so generally superseded, that more than its mere mention is hardly necessary.

Abscission is performed with knives such as those mentioned, with scissors, with cutting forceps, and with guillotines similar to those used for abscission of tonsils. Knives are open to the objection of inflicting injury on the epiglottis, the tongue, or some other structure, in their withdrawal. Scissors (Fig. 1085) are rarely used, but are more effective than knives. Guillotines are much the safest instruments, especially the guarded guillotine of Stoerk

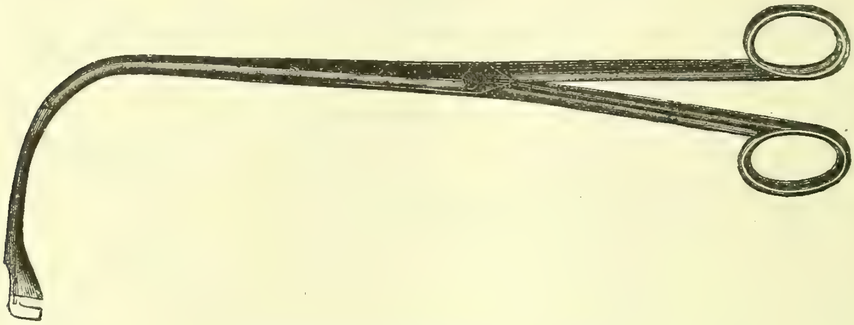
Fig. 1084.



Laryngeal knives. (Tobold.)

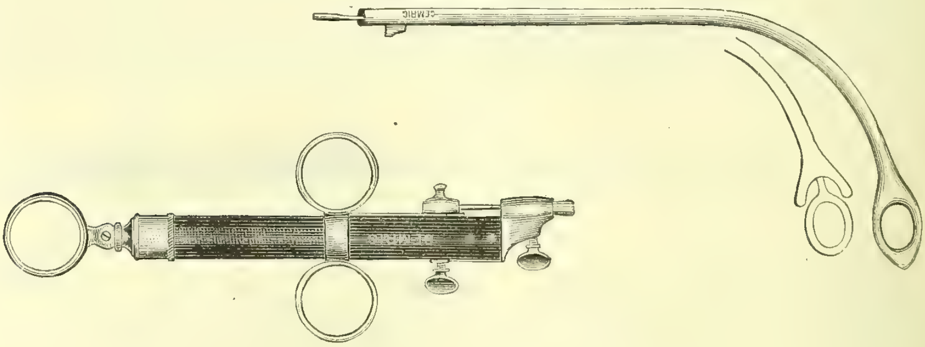
(Fig. 1086), perhaps the best of its class, which protects the adjacent tissues from the knife; but they can be used only with growths small enough to be encircled by the annular blade, and their usefulness is therefore much restricted. Personally, I am not partial to any of these cutting operations; and have virtually discarded them. It is rarely that a satisfactory incision can be made in a single movement. Furthermore, the hemorrhage produced, slight though it may be, produces cough, and usually obscures the field to an extent that prevents further manipulation at the time. The opinion that injury may result from forcible inspiration of the portions of growth detached, is to some extent justifiable, although the fragments are usually ejected by coughing. Excision of fragments, by the cutting blades of forceps of the same shapes as are used in evulsion, is requisite in cases of large growth, and is usually a satisfactory procedure. The portions excised are removed in the grasp of the instrument. As the capacity of this is limited, a number of excisions are necessary, usually requiring several sittings, should the field become at all obscured by blood. The hemorrhage in all these procedures is rarely of much significance. Dr. Edward Lori removes laryngeal growths with catheter-polypotomes—metallic catheters with eye-holes at various positions around their distal extremities, the edges being sharpened so as to cut through any soft morbid growths which may be caught in them. Ross-

Fig. 1085.



Perpendicularly cutting scissors. (Tobold.)

Fig. 1086.



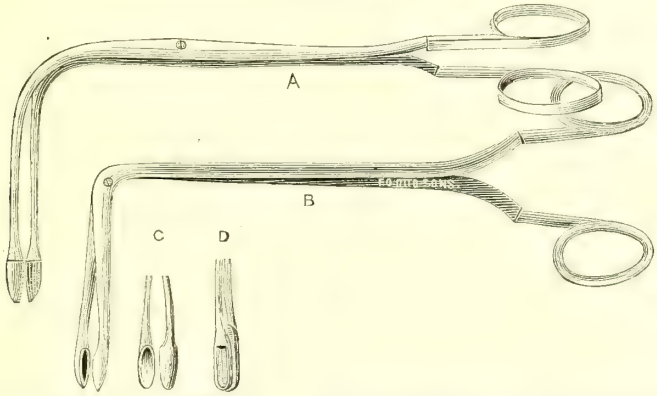
Stoerk's universal handle, with two forms of guillotine.

bach[1] introduces a knife through the lamina intermedia of the thyroid cartilage, and manipulates it under guidance of the laryngoscopic mirror.

Crushing compression of a growth is practised in cases which resist evulsion with forceps, or in which it becomes apparent that too much force would be requisite to tear the growth away. The object is to produce mortification, and thus favor subsequent detachment by suppurative processes. Crushing is practised with strong forceps similar to those used for evulsion.

Evulsion, or tearing the growth away bodily, is the method most frequently applicable. Pedunculated growths are readily torn away; and sessile growths likewise can often be torn away in mass. Soft growths of large size are usually torn away in fragments, two or three being removed at a sitting. Many sittings are often requisite to free the larynx from extensive growths. These operations are performed with forceps—simple, complex, canulated, rigid, and elastic. Many operators have devised forceps to meet their special preferences; but, as with most surgical implements, the simplest are the best. The forceps devised by Mackenzie, of London (Fig. 1087), certainly fill the greatest number of indications, and are, perhaps, the most useful of the entire class. Too much force should not be exercised in evulsion; a growth may be so firmly attached that the whole larynx is lifted with it. Under such circumstances cutting forceps should be substituted. Wire-snares, and even *écraseurs*, have been used to remove growths by cutting and by evulsion, but their manipulation is so difficult and uncertain that they are of questionable value. Evulsion with the finger or finger-nail is occasionally practicable with soft growths high up, especially in children. Evulsion is also practicable by passing a sponge into the larynx and twirling it around and around, rather roughly. Although chiefly applicable to soft growths, Voltolini, of Breslau, who is the originator and chief advocate of this procedure, has reported successes obtained by it with fibromata and myxomata, pedunculated and sessile.[2] In the treatment of growths of hard consistence, the manipulations are repeated at intervals of from four to eight days, until the growth becomes mortified and drops off. Voltolini has also recently devised a fork for the transfixion and excision of laryngeal growths.

Fig. 1087.



Mackenzie's laryngeal forceps. (Mackenzie.) A. Lateral toothed forceps. B. Antero-posterior cutting forceps. C. Spoon-blade. D. Punch-blade.

Although laryngoscopy has given the great impetus to removals of growths by intra-laryngeal procedure, operations were successfully performed in this way by Koderick, of Brussels, in 1750, and by Horace Green, of New York, in 1845. Dr. Green,[1] in fact, performed Voltolini's operation, but attributed too much of the good result to the solution of silver-nitrate in which he was accustomed to dip the sponge.

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[1] Berlin, klin. Woch., No. 5, 1880.

[2] Monatsschrift für Ohrenheilkunde, 3 November, 1878.

Treatment by Direct Access.—While the great majority of intra-laryngeal neoplasms are so accessible to treatment by way of the mouth as to render an external operation unjustifiable, the location and magnitude of a growth, the timidity and intractability of the patient, or the limited resources of the surgeon, may render an intra-laryngeal procedure hazardous and impracticable. Under such circumstances, safety may often be secured by performing a prophylactic tracheotomy first, and trying intra-laryngeal measures afterwards. Urgency for interference, and assurance that the tissues shall be thoroughly cleared of morbid growth, sometimes create an imperative demand for external access to the neoplasms. Several operations are practised for this purpose, the choice depending on individual requirements. These operations include section of the middle crico-thyroid ligament; section of the thyroid cartilage in the middle line; section of both of these structures; section of the entire larynx; section of the trachea; and section of the thyro-hyoid membrane. Section of the cricoid cartilage should be avoided if practicable, on account of its liability, slight as this may be, to be followed by necrosis. Section of the thyroid cartilage is to be avoided if other means will furnish ample access to the neoplasm, because the cicatricial agglutination of the anterior portions of the vocal bands cannot be effectively prevented. The resulting shortening of their vibrating portions impairs the voice, the shrill accentuation of which subjects a sensitive female to continuous mortification.

Section of the middle crico-thyroid ligament, *meso-chondric laryngotomy*, the easiest operation of the series, involves the least risk, leaves an insignificant cicatrix, and does not injure the voice. It offers sufficient access to small growths beneath the vocal bands, or upon their edges, inaccessible to intra-laryngeal procedure; and is indicated in individuals whose means of livelihood depend upon the integrity of the voice, or in others who are rendered irritable by the presence of growths which impair the voice, even though the function of respiration remain undisturbed. The growth once exposed, may be removed with delicate scissors, forceps, or electric cautery. In the adult, the external wound is usually amply capacious for the temporary retention of a canula when this is advisable.

Section of the thyroid cartilage, *thyrotomy*, *thyroidotomy*, *thyroid laryngotomy*, is indicated to remove extensive intra-laryngeal neoplasms which are inaccessible to thorough laryngoscopic operation, or to the simpler external procedures. Its liability to impair the voice irretrievably, renders it questionable, at times, whether the more conservative operation of sub-hyoid pharyngotomy would not be the preferable procedure, especially in the case of children, and when the growth is located very high up. Should section of the thyroid cartilage expose the interior sufficiently, the crico-thyroid ligament should be spared. Should section of both these structures prove insufficient, it will become necessary to divide the cricoid cartilage in addition. If sufficient access can be secured without dividing the thyroid cartilage quite up to the thyro-hyoid membrane, a little strip may be spared, in order to secure such cicatrization as may better ensure retention of the vocal bands in their original planes, and thus cause less impairment of the voice. The operation, whatever its extent, is usually practised after a preliminary tracheotomy, whether at the time or a few days in advance. It can often be undertaken with perfect safety, however, without such precaution.

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[1] On the Surgical Treatment of Polypi of the Larynx and Œdema of the Glottis, p. 71. New York, 1852.

Section of the trachea, *tracheotomy*, is sometimes practised for the purpose of operating upon subglottic growths, directly through the tracheal wound. In a few tracheotomies by myself, preliminary to intra-laryngeal operations, I have failed to make immediate use of the incisions in removing the growths, because the entrance of blood into the trachea, and the cough excited, have so obscured the field and disturbed the illumination that the practice has not appeared safe; but I have made successful use of the wound a few days after the tracheotomy.

Lateral Laryngotomy.—Luschka has described[1] a lateral thyroidal laryngotomy suitable for gaining access to morbid growths in the ventricle without doing injury to the vocal bands. A longitudinal incision is made down to the thyroid cartilage, starting at the junction between the first and second fourths of the horizontal interval between the superior incisure of the thyroid cartilage and its posterior border. The thyroid cartilage is then split from top to bottom, and its edges held asunder with blunt hooks, when the upper end of the laryngeal sac comes in view, so that no difficulty is presented in dividing its lateral wall as far as the level of the upper surface of the vocal band. I am unaware that this operation has ever been performed on the living subject.

Section of the thyro-hyoid membrane, *sub-hyoid pharyngotomy*, sometimes called *supra-thyroid laryngotomy*, rarely affords sufficient access for the efficient use of instruments, even in the adult, and its usefulness is therefore restricted. The operation is comparatively easy, and does not subject any important structure to injury, either at the time or subsequently. It is sometimes practised to excise the epiglottis, or to remove a growth from the upper portion of the larynx, or to extract impacted foreign bodies, otherwise inaccessible. It is an operation imitating the wound sometimes made by the suicide. First practised by Bichat in physiological investigations upon animals,[2] its performance on the human subject for surgical purposes was suggested by Malgaigne[3] and by Vidal (de Cassis), and it was first executed by Dr. Prat[4] for removal of a tumor of the epiglottis. Of six cases of this operation for removal of tumors, collated by me in 1878,[5] three terminated fatally within a few days after the operation. The operation itself, however, is not a serious one under ordinary circumstances, as no important structures, vessels, or nerves, are subjected to injury; but its limited availability rarely justifies its employment for the removal of morbid growths, especially because, as intimated by Mackenzie, cases favorable for its performance are just those most easily treated through the mouth.

To perform this operation, a transverse incision is made parallel with the lower border of the hyoid bone, dividing skin, fascia, sterno-hyoid muscles, hyo-thyroid membrane, and pharynx—button-holeing the tissues between the tongue and the epiglottis. The epiglottis is then drawn out through the wound, and the pharyngeal outlet of the larynx is exposed. The advantage over splitting the larynx is the avoidance of injury to the cartilage and to the vocal bands.

The removal of tumors exposed by direct access is effected by holding the edges of the severed tissues apart, illuminating the interior by direct or reflex light, as may be most effective, and then removing the growth with knife, scissors, wire or chain loop, or electric cautery, as may seem most feasible and judicious. The surfaces from which the growths have been removed should then be thoroughly cauterized with the thermic cautery, silver-nitrate, or zinc-chloride, to destroy remnants and prevent repullulation. These manipulations are by no means easy. The spasmodic heaving of the parts when touched with an instrument, the cough, and the hemorrhage, often interfere with a continuous operation and render its steps uneven, uncertain, and tedious. Should preliminary tracheotomy have been performed, the canula should be retained in use until it has become evident that intra-laryngeal cicatrization has been safely accomplished.

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[1] Der Kehlkopf des Menschen, S. 18. Tübingen, 1871.

[2] Traité d'Anatomie Descriptif, t. ii. p. 402. Paris, 1819.

[3] Manuel de Médecine Opératoire. Paris, 1835.

[4] Gaz. des Hôp., No. 103, p. 849. 1859.

[5] Op. cit., p. 575.

It is hardly necessary to enter into any argument as to the preference to be given to intra-laryngeal procedures over the operations just described. If a tumor can be removed by way of the mouth, with safety to the patient, he should not be unnecessarily subjected to an external operation. If the matter be doubtful, a preliminary tracheotomy should insure him from suffocation under the manipulation. If, however, the growth be below the vocal bands, and inaccessible through the mouth, or if it be so extensive as to preclude thorough eradication by way of the mouth, the external operation should be resorted to without wasting valuable time in tearing little bits away to no purpose.

Malign Tumors.—These growths, malignant histologically and clinically, comprise the groups Sarcoma and Carcinoma.

I. *Sarcoma.*—The varieties of sarcoma reported as having been seen in the larynx, comprise the spindle-celled, round-celled, giant-celled, and mixed-celled, and the composite neoplasms, fibro-sarcoma, lympho-sarcoma and myxo-sarcoma. Sarcoma of the larynx is usually single, and rarely exceeds the size of a small walnut or of a pigeon's egg. Some examples have been reported the size of small beans. The disease is rare, only twenty-three instances having been collected as the basis of an admirable study by Mr. Butlin,[1] to which, and for which, I beg here to acknowledge my own indebtedness. Most cases are primary. A few have been reported as secondary.[2] Most sarcomas originate

Fig. 1088.

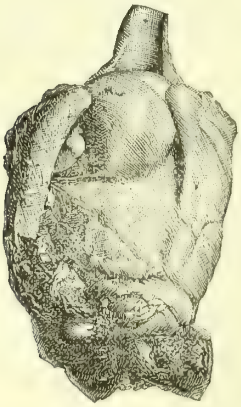
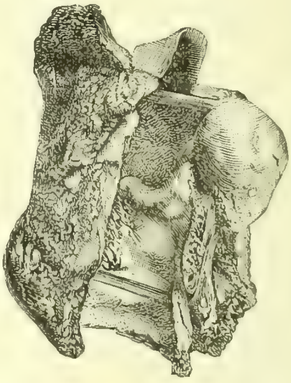


Fig. 1089.



Small-celled sarcoma on left ventricular band. (Jurist.) Fig. 1088, Before section of larynx. Fig. 1089, Larynx opened posteriorly.

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[1] On Malignant Disease (Sarcoma and Carcinoma) of the Larynx. London, 1883.

[2] Eppinger (Klebs, Handbuch der pathologischen Anatomie, Bd. ii. Abth. 1, S. 209. Berlin, 1880).

in the interior of the larynx, and principally upon the vocal band or on the ventricular band (Figs. 1088, 1089), as irregular, spheroidal masses, smooth, nodulated, mammillated, or even somewhat dentritic. Thence the growth may extend outward by infiltration, penetrating not only the membranous, but even the cartilaginous framework of the larynx.

The epiglottis seems to be the most common seat of sarcoma of the larynx originating outside of the actual aërial tract. The disease seems to extend only by continuity of tissue, and not by lymphatic involvement or by secondary formation. It is most frequently seen in patients between the ages of twenty-five and fifty, and far the more frequently in males. Its progress is not apt to be quick, for the first year or two; but it sometimes becomes exceedingly rapid.

Symptoms.—The subjective symptoms are those of neoplasms generally: dysphonia, dyspnœa, sensation of foreign body, cough, and dysphagia, all varying in intensity with the location, size, and mobility of the tumor. Pain is quite infrequent. The symptoms of a tumor large enough to produce death by suffocation may even be too slight to prompt the patient to seek medical advice. Thus in the unpublished case from which the specimen shown in Figs. 1088, 1089 was taken, and for which I am indebted to Dr. Louis Jurist, one of the Chiefs of Clinic in the throat-department of the Jefferson Medical College Hospital, the patient, a gardener, sixty-five years of age, had not applied to a physician until forty-eight hours before his death, which took place within less than twenty-four hours after he had declined to undergo tracheotomy, proposed by Dr. Jurist as the immediate outcome of a laryngoscopic examination.

Diagnosis.—Sarcoma usually appears as a well circumscribed, hard, sessile tumor, smooth or lobulated, sometimes somewhat dentritic at the surface, the mucous membrane being sometimes paler than normal, sometimes deeply congested, sometimes vascular. Superficial ulceration to a limited extent occurs in some instances. These characters are easily recognizable in the laryngoscopic image. Dendritic sarcomata may readily be mistaken for papillomata; but a dendritic formation in the posterior portion of the larynx would be probably a sarcoma, as papillomata are almost always located anteriorly.

Sarcoma is distinguishable from carcinoma by non-involvement of the lymphatic glands—a fact of the greatest clinical value, and accounted for by Mr. Butlin[1] in the suggestion that the lymphatic vessels become mechanically obliterated in the growth of the tumor. The importance of discrimination from benign growths on the one hand, and from carcinoma on the other, renders it essential to remove, with cutting forceps, a small portion of the growth for its submission to careful microscopic examination.

Prognosis.—Unsubmitted to operation, sarcoma is fatal; death occurs by asthenia, or by suffocative apnœa from occlusion of the air-tract. In cases of extensive disease, recurrence will take place unless the extirpation of the growth has been thorough. If the diseased tissues be entirely removed, the prognosis as to life is rendered favorable. Good results have followed procedures involving partial or complete laryngectomy. (See tables in section on Laryngectomy.)

Of five patients upon whom total laryngectomy has been performed[2] for sarcoma, one, operated upon by Lange, lived nearly seven months; one, by Czerny, nearly fifteen months; and one, by Foulis, nearly seventeen and a half months; one, operated on by Caselli, was alive nearly two years (August, 1881) after the operation; and one, operated on by Bottini, February 6, 1875, is alive nearly ten years after the operation.[1] Correspondence instituted for the purpose has failed to elicit the present state of Caselli's patient.[2] Taking for granted that death was imminent in these five cases, we find considerable prolongation of life in all of them, and a remarkable prolongation in two. These statistics, therefore, indicate that the operation of excision of the larynx deserves the serious consideration of the surgeon in otherwise hopeless cases of sarcoma.

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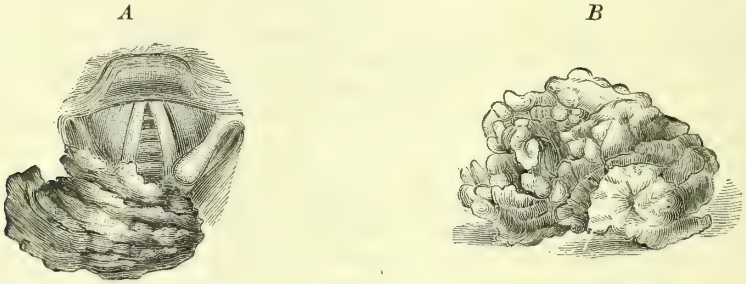
[1] Op. cit., p. 14.

[2] Transactions of the College of Physicians. Philadelphia, 1883.

Treatment.—Radical treatment must be surgical. When the growth is small and readily accessible in all its parts, operative procedures may be limited to the region diseased. Cures by intra-laryngeal operation have been reported by Tuerck, Gottstein, Navratil, and Mackenzie,[3] but the infiltrating character of the growth, so strongly insisted on by Mr. Butlin, renders it questionable whether such measures should be relied upon, and renders it imperative that the patients should be subsequently examined from time to time, to ascertain whether apparent cures have been permanent. When the growth occupies a peculiarly favorable position upon the posterior wall of the larynx (Fig. 1090), it is accessible through the mouth; and when it occupies the epiglottis, that structure may be removed—sometimes through the mouth, and sometimes by the operation described as sub-hyoidean pharyngotomy. When the interior of the larynx is the seat of the disease, thyroid laryngotomy, or section of the thyroid cartilage, or perhaps section of the entire larynx, will be required to afford proper access for efficient removal. When such exposure of the parts is insufficient for thorough eradication of the diseased tissues, the question of partial or complete extirpation of the larynx may be entertained; for the results of these operations for sarcoma, as exhibited in the tables hereafter given, are far more satisfactory than when they are undertaken for carcinoma.

Fig. 1090.



Sarcoma growing from the posterior surface of the cricoid cartilage. (Mackenzie.) *A, in situ; B*, after removal.

II. *Carcinoma.*—Carcinoma is much more frequent than sarcoma; more frequent, perhaps, than is generally recognized. Most frequently a primary disease,[4] and limited to the larynx, it occurs also in extension from disease in contiguous organs—the tongue, œsophagus, pharynx, or palate, in one direction, and the thyroid gland[5] in the other. Squamous-celled carcinoma occasionally excites consecutive disease in other organs.[1] The growth may be first developed in the interior of the larynx (*intrinsic carcinoma*, Krishaber), or in the epiglottis and the external wall (*extrinsic carcinoma*, Krishaber). It occurs most frequently as epithelioma (*squamous-celled carcinoma*, Butlin), sometimes as large spheroidal-celled,[2] occasionally as small spheroidal-celled, and very rarely as cylindrical-celled carcinoma. Intrinsic carcinoma, at least at first, is usually unilateral—the left side being involved the more frequently—and begins in the superior portion of the larynx, especially at the vocal band. Afterwards, both sides become involved. All the infra-glottic tumors cited by Butlin,[3] five in number, were situated immediately beneath the vocal band. The disease seldom extends to the œsophagus, or penetrates externally. Extrinsic carcinoma affects the epiglottis most frequently, and occasionally exclusively. It has been known to begin in the cutaneous cicatrix following thyroidal laryngotomy.[4]

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[1] Private letter from Prof. F. Massei, dated October 7, 1884.

[2] It must be noted, in connection with this case, that Margary (Arch. Ital. di Laringologia, p. 132. 1882), states that the growth was a granuloma, and not malignant. A private communication to myself, from another Italian physician of authority, reiterates this opinion.

[3] Op. cit., p. 351, vol. i.

[4] Ziemssen, Handbuch der speciellen Pathologie, u. s. w. Bd. iv. H. 1. 1875.

[5] Eppinger (Klebs, op. cit., Bd. ii. Abth. 1, S. 213).

Carcinoma rarely remains circumscribed, for its tendency is to infiltrate and destroy all the tissues of the larynx, and the tissues immediately contiguous, extending at times into the pharynx or out upon the neck. The large spheroidal-celled variety exhibits greater tendency to ulceration extending to adjoining tissues, the squamous-celled variety greater tendency to ulcerative destruction of its own mass; hence hemorrhage often results, always exhausting, occasionally fatal. Perichondritis, abscess, necrosis, and fistula occur in some cases of long standing. Lymphatic involvement is not constant with any variety, and is much less frequent in intrinsic than in extrinsic carcinoma.

Carcinoma is far the more frequent in adults, and in greatest frequency between the ages of fifty and seventy. Yet it has been detected during the very first year of life,[5] and at three years,[6] and has occurred as late as at eighty-two years.[7] It is much the more frequent in males—in the proportion of three to one, according to some compilations, and in much greater proportion according to others. This preponderance has suggested an impression[8] that the larynx of the male may be subject to some undetermined influence which in females diverts carcinoma to the uterus. Possibly the pleasures of the table, the vices of the tavern, the greater use and abuse of the voice, and the greater exposure to cold, on the part of men, may be factors in its etiology. A severe cold is often mentioned as the starting-point, and chronic laryngitis certainly precedes the disease in many cases. Traumatism is an occasional exciting cause.[9]

Benign growths are sometimes followed by malign ones; occasionally in apparent recurrence,[10] occasionally as the direct result of intra-laryngeal meddling, occasionally as the apparent result of long-continued irritation in the functional activity of the larynx. Gussenbauer[11] has had occasion to excise the larynx, for recurrent carcinoma, from an individual in whom twenty years before Czermak had detected, laryngoscopically, a small, circumscribed nodule on a vocal band, and had explained to the patient that an operation would be eventually necessary, and from whom, some ten years afterwards, the neoplasm had been removed by Stoerk.

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[1] Sands, New York Med. Journ., p. 110. 1875; Desnos, Bull. de la Soc. d'Anat., 4e sér., t. iii. p. 398. 1878. (Cited by Butlin.)

[2] Fauvel (op. cit., p. 689) reports 16 cases of epithelioma and 19 of encephaloid, out of a total of 37 cases of primary carcinoma, the nature of two of which was doubtful.

[3] Op. cit., p. 36.

[4] Cohen, Transactions of the American Laryngological Association, p. 113. 1883.

[5] Dufour, Bull. de la Soc. d'Anat., p. 53. 1865.

[6] Rehn, Virchow's Archiv, Bd. xliii. S. 129. 1868.

[7] Preisendoerfer, Berliner klin. Woch., Nos. 43 und 48. 1878.

[8] Fauvel, op. cit., p. 696.

[9] Demarquay, cited by Blanc (Étude sur le cancer primitif du larynx, p. 57. Paris, 1872); Cohen, Transactions of the Pathological Society of Philadelphia, vol. vii. p. 82. 1879; Transactions of the American Laryngological Association, vol. v. p. 117. 1883.

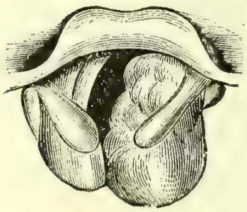
[10] Clinton Wagner, Archives of Laryngology, April, 1883, p. 130.

[11] Prager medicinische Wochenschrift, No. 31, 1883.

Symptoms.—Dysphonia is usually the earliest symptom to attract attention, sometimes existing for many months, even for two years or more, before any alarm is experienced. Then follow pain, in many instances extending towards the ears and along the neck; dysphagia, when the disease occupies or mounts the upper border of the larynx; cough; salivation; expectoration, which becomes bloody, and perhaps fetid, after the ulcerative stage has commenced; and dyspnœa, proportionate to the mechanical obstruction present. The dysphonia may augment to aphonia. Paralytic aphonia is indicative of nerve-compression. Apparent paralytic aphonia may be due to immobility of a vocal band caused by pressure from a tumor beneath it. In extrinsic carcinoma, the dysphagia precedes the dysphonia. The dysphagia may augment to positive aphagia. Both dysphagia and dysphonia may be due to collateral œdema. The dyspnœa is usually greater in inspiration than in expiration, and often undergoes paroxysmal increase, especially at night. Spasm is an occasional phenomenon. When the tumor has attained sufficient size, the dyspnœa may augment sufficiently to threaten suffocation; but should losses of tissue take place by suppuration and expectoration, these respiratory phenomena become less intense, or subside altogether, and sometimes the aphonia undergoes amelioration likewise. Finally, emaciation, fever, and marasmus ensue.

Diagnosis.—The subjective symptoms are insufficient to establish the diagnosis. The somewhat characteristic shooting pains are sometimes produced in other affections, and are absent in many cases of carcinoma. Laryngoscopically, a diffuse swelling in a circumscribed locality is the earliest objective indication, but this is insufficient for correct diagnosis. Subsequently a distinct tumor becomes developed, undergoes nodulation, and then ulceration. In some instances, chiefly those of extrinsic carcinoma, the progress of the disease is attended with swelling, first of the submaxillary, and then of the cervical lymphatic glands. Finally, the usual carcinomatous cachexia becomes evident; but less pronounced than with carcinoma elsewhere. Thus the disease must usually be of some months' standing before diagnosis by mere inspection can be accurate. Squamous-celled carcinoma is usually first recognizable as an undiscolored, globose swelling; afterwards it becomes pale, wrinkled, and nodulated. It is apt to become overlaid with papillomatous excrescences, especially when occupying the vocal bands. Large spheroidal-celled carcinoma is usually first recognizable as an undiscolored, irregular, and uncircumscribed tumor; soon becoming nodulated, dark, and irregularly vascular, and finally undergoing ulceration at one or more points. In the advanced stages of the disease there is little difficulty in the diagnosis. The characteristic irregular, nodulated, vascular and ragged aspect of the surface, leaves little room for doubt. And even this doubt can be cleared away by microscopic examination of fragments removed for the purpose; a harmless practice which should be instituted at the very earliest opportunity as a guide for proper treatment. Discrimination between the varieties of carcinoma is otherwise impossible in their early stages. In the ulcerative stage of intrinsc carcinoma of moderate dimensions, or of carcinoma of the epiglottis, the disease is liable to be mistaken for syphilis, and, perhaps, for tuberculosis.

Fig. 1091.



Large spheroidal-celled carcinoma at an early stage.

Prognosis.—This is unfavorable. Recurrence is almost inevitable, no matter what the surgical procedure adopted. The small spheroidal-celled variety progresses with the least, and the large spheroidal-celled with the greatest rapidity, the squamous-celled being intermediate. The average term of life, without operation, in the last variety, varies from two to four years. Intrinsic carcinoma affords a much better chance of prolonging life by surgical interference than extrinsic carcinoma, which is practically hopeless. Death may take place by sudden apnœa, asthenia, hemorrhage, collapse, or pyæmia. Tracheotomy, performed when the dyspnœa begins to be urgent, not only ameliorates suffering, but prolongs existence. According to Fauvel's statistics, derived from his own practice,[1] life is prolonged by tracheotomy to much the longest time in the squamous-celled variety. Thus 7 patients with "encephaloid cancer" lived, without operation, for an average of 3 years, while 8 on whom tracheotomy was performed averaged 3 years and 9 months; and 6 patients with "epithelioma" lived without operation for an average of one year and 9 months, while 7 after tracheotomy averaged 4 years. The parity in numbers gives these statistics a special value. Some observers claim that early tracheotomy, although not indicated by progressing dyspnœa, prolongs life as a remedial agent. After the formation of an artificial opening and the removal of obstructing masses, whether through the mouth or through the wound, the recurring growth may force its way to the exterior through the latter, or, as I have seen after low tracheotomy, it may rupture an intact crico-thyroid membrane, and split the thyroid cartilage to give exit to its outgrowths.

Treatment.—Radical treatment involves surgical interference. Whether this should be instituted, will depend upon the extent of the disease, the vigor of the patient, and the opportunities for attention after the operation. Extrinsic carcinoma offers no prospect for cure, even though the larynx be extirpated. Intrinsic carcinoma, as yet confined to the larynx and without lymphatic involvement, may justify laryngectomy; inasmuch as consecutive disease in other parts is, to say the least, infrequent. The prospects are by far the best when the disease is unilateral and occupies but a limited portion of the larynx, so that partial exsection will suffice for complete riddance. (See section on laryngectomy.) At the meeting of the Deutschen Gesellschaft für Chirurgie, in 1884, E. Hahn, of Berlin, called attention[2] to the fact that in eleven half sections of the larynx for carcinoma, only one patient perished from the operation, while recurrence seemed no more frequent than after total extirpation, and the preservation of functions was so good that in most instances the canula could be definitively removed. It is quite probable, however, that, taking cases as they run, more benefit is to be anticipated to the greater number of sufferers, by prophylactic tracheotomy and the institution of palliative measures, constitutionally and topically. The patient should take care not to use his voice too frequently, and to avoid all risks of exciting laryngitis. The administration of arsenic is believed to have some slight modifying influence on the cachexia. Ergot is indicated to restrain hemorrhage; anodyne inhalations and insufflations of morphine diminish pain; weak solutions of silver-nitrate sometimes obtund the sensitiveness of the parts; aromatized sprays cleanse them from mucus and pus; and disinfectant sprays control the unpleasant odor. Dyspnœa requires rest of part and body. Semi-detached portions of growth impeding respiration, may be removed with forceps, and the raw surface may be subjected to slight cauterization. Under other conditions, mechanical interference is to be deprecated. When suffocative apnœa is threatening, tracheotomy is indicated, and should be performed at as great a distance below the disease as practicable. Dysphagia necessitates the use of semi-fluid or fluid nourishment. When aphagia is threatening, rectal alimentation should be resorted to in advance of its absolute necessity. Dysphagia due to an enlarged and ulcerated epiglottis may be overcome by ablation of that organ, a procedure which in my own practice has been followed with no unpleasant results, and has afforded considerable comfort. In disease limited to the epiglottis, excision of that structure after sub-hyoidean incision externally, is indicated as a radical measure.

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[1] Op. cit., p. 717.

[2] Beilage zum Centralblatt für Chirurgie, No. 23, S. 55. 1884.

The question as to the propriety of laryngectomy bids fair to be duly answered in the near future. Nearly eighty complete extirpations of the larynx are known to have been performed for carcinoma. The ultimate results, as far as can be ascertained, are herewith presented:—

From all sources, published and unpublished, I am able to present the following:—

RECORD OF DEATHS REPORTED AFTER COMPLETE LARYNGECTOMY FOR CARCINOMA.

Operator.					Cause of death.
Tilanus.	Death in	36	hours	from	collapse.
Macewen.	“	3	days	“	pneumonia.
Bottini.	“	3	“	“	“
Langenbuch.	“	3	“	“	collapse.
Schmidt.	“	4	“	“	“
Gerdes.	“	4	“	“	“
Billroth.	“	4	“	“	pneumonia.
Toro.	“	4	“	“	pulmonary emphysema.
Schönborn.	“	4	“	“	?
Hodgen.	“	4	“	“	?
Bergmann.	“	4	“	“	pneumonia.
Multanowski.	“	5	“	“	pneumonia.
Reyher.	“	5	“	“	septic broncho-pneumonia.
Pick.	“	5	“	“	pleurisy and pericarditis.
McLeod.	“	5	“	“	secondary hemorrhage.
Maydl.	“	5	“	“	severe arterial hemorrhage.
Reyher.	“	7	“	“	septic broncho-pneumonia.
Reyher.	“	7	“	“	septic pneumonia.
Watson.	“	7	“	“	pulmonary embolism.
Thiersch.	“	7	“	“	“secondary infectious” pneumonia.
Vogt.	“	7	“	“	exhaustion.
Albert.	“	8	“	“	“diffuse bronchitis and lobular” pneumonia.
Reyher.	“	11	“	“	“hypostatic” pneumonia.
Reyher.	“	14	“	“	exhaustion.
Maas.	“	2	weeks	“	pneumonia.
Watson.	“	2	“	“	“
Bircher.	“	16	days	“	pneumonia and “pulmonary gangrene.”
Hahn.	“	15	“	“	putrid bronchitis.
Novaro.	“	1	month	“	pneumonia.
Hahn.	“	4	weeks	“	suppurative bronchitis and pneumonia.
Hahn.	“	5	“	“	“ “ “ “
Billroth.	“	6	“	“	passage of bougie into mediastinum.
Multanowski.	“	2	months	“	recurrence.
Gussenbauer.	“	2	“	“	tuberculosis pulmonum.
Winiwarter.	“	9	weeks	“	inanition.
Multanowski.	“	3	months	“	“croupous” pneumonia.
Langenbeck.	“	4	“	“	recurrence.
Thiersch.	“	4	“	“	“
Novaro.	“	4	“	“	recurrence and hemorrhage consequent upon additional operative procedures.
Holmer.	“	4	“	“	recurrence.
Leisrink.	“	4	“	“	croupous pneumonia.
Burow.	“	4½	“	“	sudden suffocation.
Czerny.	“	5	“	“	recurrence.
Volker.	“	5	“	“	suffocation.
Heine.	“	6	“	“	recurrence.
Maas.	“	6	“	“	“
Margary.	“	6	“	“	profuse hemorrhage due to recurrence with extensive ulceration.

Operator.					Cause of death.
Billroth.	Death in	7	months	from	recurrence.
Holmer.	"	7	"	"	"
Novaro.	"	8	"	"	suffocation by pen (quill?) which had slipped into trachea. No recurrence.
Bruns.	"	9	"	"	recurrence.
Kosinski.	"	9	"	"	"
Reyher.	"	9	"	"	"
Novaro.	"	13½	"	"	? ("Sudden.")
Czerny.	"	15	"	"	recurrence.
Czerny.	"	18	"	"	"
Kocher.	"	2	years	"	cancerous disease of abdomen. No local recurrence.
Thiersch.	"	2½	"	"	recurrence.
Durante.	"	2 or 3 days.			
Holmes.	"	40	hours	from	collapse.

In marked contrast to the table of deaths, it is pleasant to turn to the following record, which shows remarkably happy results in patients who, as did five in the above list, survived the operation longer than one year, and all of whom are possibly still living:—

Name of operator.				Latest report of patient.				
Thiersch.	Patient	living	3	years and	7	months	after	operation.
Winiwarter.	"	"	3	"	4	"	"	"
Novaro.	"	"	2	"	3	"	"	"
Hahn.	"	"	2	"			"	"
Gussenbauer.	"	"	2	"	over		"	"
Gussenbauer.	"	"	1	year and	9	months	"	"
Maydl.	"	"	1	"	4	"	"	"
Kocher.	"	"	1	"	4	"	"	"

Professor Schede has been kind enough to write me concerning two additional laryngectomies recently performed by him, under conditions such as to justify expectation of highly satisfactory results. In addition, it may be stated that there are twelve cases, published and unpublished, the subjects of which are noted as living at periods varying between five weeks and nine months after the operation.

From the record presented, it is evident that life may be prolonged in some individual cases of carcinoma for periods sufficient to justify laryngectomy. It is incumbent upon surgery, therefore, to eliminate the elements of failure, so that the procedure may be confined to cases of promise. A vigorous individual, with an intrinsic carcinoma as yet untrenching upon contiguous structures, and exhibiting no evidence of lymphatic involvement, may be a proper subject for the operation. But despite the exceptional cases cited, the general prospect, on the score of the greatest good to the greatest number, hardly looks more encouraging than it did when I recently made it the occasion of a special investigation.[1]

Morbid Growths of the Trachea.

Benign Growths.—The trachea may become the seat of every variety of benign neoplasm. As shown by the subjoined table of reported instances of veritable neoplasms, such growths are more frequently situated on the membranous portion than on the cartilaginous, and are more frequent in the upper portion than in the lower. Quite a number occur at the bifurcation. Some are associated with similar growths in the larynx, some with growths in the bronchi, and occasionally one with growths in the œsophagus; some, especially ecchondromata and osteomata, are associated with tuberculosis. Adults are affected more than children, and males more than females. The causes are obscure. The meagre records of the patients' occupations furnish no clew in that direction.

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[1] Does Excision of the Larynx tend to the Prolongation of Life? (Transactions of the College of Physicians of Philadelphia, 1883.)

CASES OF INTRA-TRACHEAL BENIGN TUMOR.

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
1	Butlin,	Laryngo-tracheoscopically	F. 38	Large-grained papilloma.	Left side for half the circumference of trachea extending for an inch below cricoid cartilage.	Tracheotomy and evulsion with finger-nail.	Cure.	St. Bartholomew's Hosp. Reports, p. 129. 1882.	The tumor was not discovered until after several examinations, when patient had become more tractable.
2	Chiari,	At autopsy	F.	Osteoma.	A lamella 4 cm. x 3 cm. x 3-4 mm.	…………	………	London Med. Record, July 15, 1878. Mackenzie, op. cit., vol. i. p. 526.	Dead of acute tuberculosis; minute formations of similar character in bronchi.
3	Clark (A.),	At autopsy	F. 75	Lymphadenoma.	Mucous surface of trachea covered with small growths.	…………	………	Med. Times and Gaz., Dec. 13, 1873, p. 679.	Tracheotomy had been twice performed. A tumor was found behind the trachea and to either side, in addition to the small growths in the interior.
4	Cohen,	At autopsy	M.	Multiple ecchondroma.	Anterior wall.	…………	………	Trans. Patholog. Soc. Phila., vol. iv. p. 144, 1874.	Patient had died of ulcerative tuberculous laryngitis, with perichondritis, abscess, and necrosis.
5	Cohen,	Tracheoscopically	M. 6	Multiple papilloma.	Posterior wall, about opposite 2d, 3d, and 4th rings.	Evulsion with forceps and finger-nail through tracheal incision	Probable cure. No unsatisfactory report since operation.	Unpublished.	Tracheotomy performed for multiple laryngeal papillomata when patient was apparently dying; subsequently, thyroid laryngotomy to extirpate growth. These operations by Dr. Davis, of Denver, Col. A second thyroid laryngotomy by myself two years after, and thorough evulsion with forceps, finger-nail, and sharp spoon. Recurrence in trachea three months after; stricture of larynx at chink of glottis, requiring retention of tracheal canula, although a No. 22 French bougie could be readily passed.
6	Eppinger,	At autopsy	M. 23	Fibroma.	Posterior wall, 4.5 cm. above bifurcation; size of filbert.	…………	………	Klebs, op. cit., Bd. ii. Abth. 1, S. 296.	

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—*Continued.*

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
7	Eppinger,	At autopsy	......	Multiple osteoma.	Anterior wall.	....	....	Ibid., S. 299.	
8	Eppinger,	At autopsy	......	Multiple osteoma.	Anterior wall.	....	....	Ibid.	
9	Eppinger,	At autopsy	......	Multiple polypoid cyst-adenoma.	Posterior wall.	....	....	Ibid., S. 300.	
10	Fifield,	At autopsy	F.	"Pedunculated rosy polyp." (Fibroma?)	Bifurcation; size of grape.	Expectant.	Death by suffocation.	Boston Med. and Surg. Jour. Nov. 14, 1861.	
11	Flormann,	At autopsy	M. 30 boatman.	....	Size of walnut; almost entire posterior upper portion, stretching to cartilages.	....	....	Schwedische Abhandl., Bd. iv. No. 7. 1790; cited by Lewin (Deutsche Klinik, No. 20, S. 192. 1862.)	Necrosis of several tracheal cartilages.
12	Fournié,	Brought to tracheal orifice by cough	F. 17 servant.	Multiple mucous polypi. (Myxomata?)	Below tracheal incision. One, size of a filbert, others smaller.	Two removed with forceps through tracheal orifice; one with a *serre-nœud.*	Cure.	Gaz. des Hôp., No. 56. 1868.	Patient was brought to Hotel Dieu, semi-asphyxiated. Tracheotomy. Evulsion of laryngeal polyp through mouth. Afterward operations described.
13	Gerhardt,	....	......	....	....	....	....	Allg. Wien. med. Ztg., No. 33. 1861. (Koch.)	
14	Gerhardt,	....	......	Ecchondroma.	....	....	....	Jenaischen Ztsch. f. Med. u. Naturwiss., Bd. iii. S. 134. 1867. (Koch.)	Supposed to have been of inflammatory origin.
15	Gibb,	Laryngoscopically	F. adult.	Cystoma.	Anterior wall.	Expectant.	Spontaneous rupture.	Diseases of Throat, p. 392. London, 1864.	
16	Krishaber,	....	......	Fibroma?	....	....	....	Gaz. des Hôp., 1870. Eppinger.	

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—*Continued.*

No.	Observer.	How detected.	Sex, age, and occupation.	Histology	Location and size.	Treatment.	Result.	Reference.	Remarks.
17	Labus,	Laryngoscopically	M. 13 worker in woolen and cotton stuffs.	Fibro-sarcoma.	Upper rings, left lateral and posterior wall. Little larger than a pea.	Evulsion with forceps, *per vias naturales.*	Cure (seen 4 months afterwards).	Archives of Laryngology, p. 220. 1880.	
18	Labus,	Laryngoscopically	M. cheese-maker	Multiple papillary epithelioma (papilloma?)	At 5th, 8th, and 9th rings.	Evulsion *per vias naturales.*	Cure.	Arch. Ital. di Lar. p. 9. 1881.	
19	Lieutaud,	………	M. 12	"Pedunculated polyp." (Fibroma, Eppinger.)	Upper third.	…………	………	Historia. Anat. Med., lib. iv. obs. 64. Gothae, 1802; cited by Lewin (loc. cit.).	
20	Maisonneuve,	………	10½	Papilloma.	Inner surface.	…………	………	Rauchfuss (Gerhardt's Hdbch., f. Kind., Bd. iii. H.2, S.269); cited by Eppinger.	
21	Mackenzie,	At autopsy	F. 72	Papilloma.	Size of a bean.	None.	………	Brit. Med. Journ., May 30, 1874, p. 710.	Patient died of congestion of the lungs. Thyrotomy had been performed eight years previously for removal of laryngeal papilloma, a recurrent tumor having been removed in fragments through the mouth.
22	Mackenzie,	Laryngoscopically	M. 43	…………	2d and 3d rings; size of a bean.	Touched with electric cautery point.	Cure.	Op. cit., vol. i. p. 525.	
23	Mackenzie,	Laryngoscopically	F. 22	…………	3d ring; size of a pea.	A single unsuccessful attempt with electric cautery.	………	Ibid.	

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—*Continued.*

No	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
24	Mackenzie,	Laryngoscopically	M. 37 clerk.	…………	1st and 2d rings; size of a white currant.	Touched with electric cautery.	Cure.	Ibid.	
25	Mackenzie,	Laryngoscopically	M. 45	"Bright red polypus."	4th, 5th, & 6th rings anteriorly. Size of a grape.	Tracheotomy proposed and refused.	Sudden death, probably by suffocation.	Ibid.	
26	J. N. Mackenzie (Baltimore),	At autopsy	M. adult.	"Tubercular tumor."	Posterior membranous wall 1½ cm. above bifurcation; well defined and circumscribed. Size of a small bean.	…………	………	Archives of Medicine, No. 2, 1882.	Patient had died of carcinoma of stomach, with secondary deposits in several organs. Lungs contained tuberculous cavities; pharynx, larynx, and trachea free from inflammation and ulceration. Before microscopic examination the tracheal tumor was supposed to be a hard cancerous nodule.
27	Melion ?	………	……	…………	……………	…………	………	Oesterreich. med. Ztschr., No. 10, 1864. (Koch.)	A questionable case.
28	Meyer-Hüni,	Laryngoscopically	M. 27 farmer.	Fibro-sarcoma.	Left side about 3d or 4th ring. 21x18x11 mm.	Incision into trachea and removal with scissors.	Recovery (well 2 months after).	Correspondenz-blatt für Schweizer Aerzte, 1 Mai, 1881; Medical Record, Nov. 12, 1881, p. 543.	
29	Ozanam,	Laryngoscopically	F. 39	2 "polypes," rosy white and mammillated.	Symmetrically, posteriorly, at point of juncture of larynx and trachea.	Evulsion with guillotine.	Cure.	Gaz. Méd. de Paris, No. 27, 1863, p. 441.	Possibly growths on inferior surface of arytenoids as they accompanied the movements of the latter; but as papillomata are exceedingly rare in the posterior portion of the larynx, and most frequent in the posterior portion of the trachea, the example is included as a doubtful case.
30	Rokitansky,	………	……	Fibroma.	Above bifurcation.	…………	………	Wien. Ztschr., Bd. vii. S. 181; cited by Eppinger. Lehrbuch u.s.w., 3 Aufl., Bd. iii. S. 25.	

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—*Continued.*

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
31	Rokitansky,	....	M. 85 clergyman.	Lipoma. Pedunculated, size of hazelnut.	Bronch. branch of left lower lobe, just above its division.		Sudden death in collapse.	Cited by Lewin (op. cit., S. 193).	
32	Schroetter,	Laryngoscopically	M. 34 house-painter.	Papilloma, with recurring sarcoma.	Anterior wall; region of 4th ring. Recurrent tumor at posterior portion of right side and at posterior wall.	Injections of ferric chloride causing shrinkage; evulsion with forceps in recurrence.	Recurrence.	Medizinischer Jahrbücher, Bd. iii. S. 64. Wien, 1868. Jahresbericht der Klinik für Laryngoskopie, S. 80. Wien, 1871; Ibid., S. 102. 1872.	
33	Smith, A. H.	During tracheotomy	F. 14	"Inflammatory fibrinous growth."	Upper portion right side, leaving only a small passage for air at left and posteriorly.	Canula forced past obstruction.	Diphtheria supervened, with death in 4 days.	Am. Journ. Med. Sci., July, 1876.	Seems to have started in an acute laryngo-tracheitis while convalescing from measles.
34	Smoler,	....	......	....	....	....	....	Allg. Wien med. Ztg., No. 33, 1861. (Koch.)	
35	Stallard,	At autopsy	F. 40	Pedunculated polypus. (Fibroma, Eppinger.)	Half an inch beneath cricoid cartilage, at anterior portion: size of an almond; pedicle $\frac{3}{4}$ inch long.	Expectorants for asthmatic bronchitis.	Sudden death after violent paroxysm of cough.	Lond. Med. Gaz., N. S., vol. ii. p. 275. 1842–3.	Lungs emphysematous; smaller bronchi healthy; primitive bronchi highly congested. Polypus found loose in the trachea, but a portion of the pedicle remained attached at point indicated.
36	Stenier,	....	......	....	....	....	....	Jahrb. f. Kinderhlkde., 1856; cited by Eppinger.	
37	Steudener,	At autopsy	......	Multiple osteoma.	1–1½ mm.; in the mucous membrane.	....	....	Virchow's Archiv, Bd. xlii. S. 48; cited by Eppinger.	Patient died of otitis interna with cerebral involvement.

CASES OF INTRA-TRACHEAL BENIGN TUMOR.—*Concluded.*

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
38	Stoerk,	Laryngoscopically	M. 22	Multiple papilloma.	Third ring.	Tracheotomy declined.	....	Stoerk, op. cit., S. 438.	Associated with multiple papilloma of larynx.
39	Stoerk,	Laryngoscopically	M.	Multiple papilloma.	....	Tracheotomy declined.	....	Ibid., S. 439	Associated with multiple papilloma of larynx.
40	Stoerk,	Laryngoscopically	F. 40	Fibroma.	Posteriorly, size of bean.	Tracheotomy declined.	....	Ibid.	
41	Stoerk,	Laryngoscopically	M. 42	Vascular papilloma.	Just above bifurcation.	Entire trachea laid open longitudinally and evulsion with sharp spoon. (Billroth operator.)	Recovery.	Ibid., S. 440; Billroth, Clin. Surg., p. 134. London, 1881.	Recurrence; repetition of former operation; removal of a small granuloma at site of former growth; a resistant mass along the right side of trachea reaching to the sternum and compressing trachea; introduction of a canula reaching to the bifurcation; this pressed external tumor aside and eventually caused its disappearance.
42	Tuerck,	At autopsy	M. 37	Fibroma.	Posterior wall, upper portion. 6 x 2 x 4 mm.	....	....	Op. cit., S. 502, Wien, 1860.	Patient had died of pulmonary tuberculosis. At about central portion of tumor, a second roundish and more pedunculated tumor projected backward into the œsophagus.
43	Tuerck,	Laryngoscopically	M. 38 waiter.	Fibroma? (Eppinger.)	Posterior wall, upper portion. Size of small sugar-corn.	None.	....	Ibid., S. 503.	A doubtful case. But for its seat posteriorly, might have been laryngeal; no functional disturbance.
44	Tuerck,	Laryngoscopically	F. 38 waitress.	Multiple fibroma? (Eppinger.)	Right wall, very low down, one size of a hemp-seed, another smaller one near first. Several minute growths at commencement of left bronchus.	None.	....	Ibid.	
45	Wilks,	At autopsy	? 38	Multiple osteoma.	Anterior wall; small, submucous, intercartilaginous.	....	....	Trans. Path. Soc. London, vol. vii. 1857; cited by Tuerck and by Mackenzie.	Patient had died of phthisis; similar formation in bronchi.

Granulomatous Formations.—Pedunculated polypoid vegetations, rarely larger than peas, sometimes occur upon the intra-tracheal cicatrix, usually within two months after closure of the wound of tracheotomy. Microscopically, they are similar to the cauliflower excrescences, or exuberant granulations, which so often occur around the edges and along the track of the wound, while the canula is in position, when the parts are not properly dressed—or which occur upon ulcerated portions of the mucous membrane under attrition by the tube—but they seem to acquire an epithelial investment sometimes covered with cilia. While histologically not veritable neoplasms, they may be regarded clinically as benign tumors, inasmuch as they produce the same symptoms, present the same dangers, and require the same treatment—namely, incision into the trachea, thorough evulsion, and cauterization of their points of implantation. They may even be reproduced on the second cicatrix, and thus necessitate a third tracheotomy.[1] These growths are sometimes described as polypi. They have been especially studied by Petel.[2]

Krishaber, St. Germain, Verneuil, and others, believe that these formations proceed from intact mucous membrane, and thus antedate the tracheotomy. Millard and Harvey, and other observers, contend that they originate in blood-clots which become adherent. In a case communicated to me by Dr. A. H. Smith, of New York, a deep-pink growth, the size of a currant, was seen, apparently attached to the left side of the cicatrix, six weeks after the tracheotomy. Streaks of blood appeared in the expectoration, and after quite a large clot of dark blood had been coughed up, the breathing became easy; and, on laryngoscopic examination, the growth was found to have disappeared. Petel records a growth discovered upon the tracheal surface of a tracheotomy-cicatrix in the body of a man, sixty-nine years of age, who had committed suicide, but concerning whose previous history no details could be learned.

The much more frequent granulomatous vegetations occurring after tracheotomy, have been discussed in connection with croup and diphtheria, among the causes which prevent early removal of the canula (page 711). They have been elaborately studied by Koch.[3]

MALIGN TUMORS.—*Sarcoma and Carcinoma.*—As will be seen by the first of the subjoined tables, short as it is, *sarcoma* seems to occur in the trachea with greater proportionate frequency than it does in the larynx; for the thousands of laryngeal growths reported include few sarcomata. The apparent preponderance may be due to the circumstance that laryngeal growths, being much more common, are less frequently reported or submitted to minute examination, and that thus some laryngeal sarcomas go unrecognized. The recorded cases of fibro-sarcoma, two in number, having been cured without resort to radical measures, have been tabulated among those of benign growth. *Carcinoma* of the trachea is rare as a primary disease, the cases collected in the second of the subjoined tables comprising all at my immediate command. It will be observed that it is most frequent in the upper portion of the tube, that it is most frequently located on the membranous wall, and that it is sometimes associated with primitive carcinoma of the bronchi. The records are too meagre to show the comparative frequency of the different varieties. Males and females seem to be susceptible in equal proportions, and all the instances recorded have occurred in adults.

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[1] Koch, Archiv für klinische Chirurgie, Bd. xx. S. 542. 1877.

[2] Des Polypes de la Trachée. Paris, 1879.

[3] Loc. cit., S. 540–558.

CASES OF INTRA-TRACHEAL SARCOMA.

No.	Observer.	How detected.	Sex, age, and occupation.	Histology.	Location and size.	Treatment.	Result.	Reference.	Remarks.
1	Eppinger,	At autopsy.	……	Lympho-sarcoma.	Above bifurcation; hemi-spheroidal; size of a nut.	………………	…………	Op. cit., S. 298.	Started from a sarcoma of bronchial gland, which had penetrated the soft tissues of trachea.
2	Schroetter,	Laryngoscopically.	F., 19.	Sarcoma.	Right wall.	Injection of ferric chloride by an inexperienced hand.	Death under operation.	Laryngologische Mittheilungen, S. 102. Wien, 1875.	After refusing treatment from Schroetter, the patient fell into other hands.
3	Schroetter,	do.	M., 34. House painter.	Sarcoma.	…………………	………………	…………	See case No. 32, in table of benign growths.	

CASES OF PRIMARY INTRA-TRACHEAL CARCINOMA.

No.	Observer.	How detected.	Sex, age, and occupation.	Location.	Histology.	Treatment.	Result.	Reference.	Remarks.
1	Delafield,	At autopsy	F., 27.	Small portion of lower part.	Squamous-celled (apparently epithelial cancer).	………………	Death from suffocation.	New York Med. Journ., vol. xxxvi. p. 406. 1882.	In connection with similar disease nearly obliterating the primitive bronchi. Dyspnœa supposed to be aneurismal.
2	Isambert,	Laryngoscopically.	M. "old." Journalist.	High up "some distance below right vocal band."	…………………	Tracheotomy in emergency.	Death despite the tracheotomy.	Conférences Cliniques sur les Maladies du Larynx, etc., pp. 257–9. Paris, 1877.	Result of examination after death refused by the interne of the hospital where it took place.
3	Isambert and Krishaber,	Laryngo scopically.	M. ? Manufacturer.	Deeply situated.	…………………	Electric cautery, producing need for immediate tracheotomy.	Death in dyspnœa on third day.	Ibid., pp. 259–61.	Cancerous tumor found in the portion of trachea removed at autopsy, cut off above the point of insertion. Specimen presented to the Société de Chirurgie, in 1874.

CASES OF PRIMARY INTRA-TRACHEAL CARCINOMA.—*Concluded.*

No.	Observer.	How detected.	Sex, age, and occupation.	Location.	Histology.	Treatment.	Result.	Reference.	Remarks.
4	Klebs,	At autopsy	......	....	Cylindrical-celled.	....	....	Friedreich ; cited by Eppinger (Klebs, op. cit., Bd. ii. Ab. 1, S. 301).	
5	Koch,	....	F., 37. Servant.	....	Large spheroidal-celled. "Markschwamm."	....	....	Ztschr. f. Wundärzte u. Geburtshelfer, Bd. xxi., 1868 ; cited by Eppinger.	
6	Langhans,	At autopsy	M., 40.	Bifurcation. Posterior and lower; 7 mm. thick, extending 2½ cm. into right bronchus.	Small polygonal or cylindrical celled (nested).	....	....	Virchow's Archiv, Bd. liii. S. 470. 1871.	Originating in the mucous glands, and associated with primitive carcinoma of the bronchi.
7	Mackenzie (April, 1864),	At autopsy	F., 87.	Middle third ; originating from 3 sides, chiefly the posterior, and extending to within half an inch of the cricoid cartilage.	Squamous-celled (typically epithelial).	....	Death (Jan. 1865).	Op. cit., vol. i. p. 529.	Great tracheal stenosis.
8	Morra,	At autopsy	M., 62.	Upper portion of posterior and lateral wall.	"Medullary."	....	....	Giorno. Intern. dell Scien. Med., Nos. 10–11, 1879, p. 1129.	Paralysis of laryngeal abductor noted during life. Growth associated with carcinoma of both lobes of thyroid gland.
9	Rokitansky,	At autopsy	F.	Upper posterior portion to an extent of 2 inches.	Large spheroidal-celled? "Markige Geschwultsmasse."	....	....	Friedreich; cited by Eppinger.	
10	Schroetter (May, 1869),	Laryngoscopically.	M., 56.	Posterior wall from 3d to 5th rings.	"Ulcerating."	Expectant.	Repeated hæmoptysis. (July, Aug., Sept.) Death in Sept.	Laryngologische Mittheilungen, S. 86. 1871.	
11	Schroetter (May, 1871),	....	M., 51.	Posterior and right lateral wall.	Small spheroidal-celled (fibrous), red and blue roundish masses, from size of seeds to that of beans.	Tracheotomy.	Death in 4 hours.	Ibid., S. 102. 1875.	

Secondary carcinoma seems still more rare, the only record at command being an instance of primary carcinoma in the upper third of the œsophagus, reported by Eppinger,[1] in which a roundish, metastatic nodule, the size of a walnut, was developed at the bifurcation, half of it projecting inward into the lumen of the trachea, and the other half being imbedded between the trachea and the œsophagus. Eppinger mentions also that disseminated melanotic patches occur in the tracheal mucous membrane as metastases from primary melanotic carcinoma of the skin.

Carcinoma of the trachea in extension of carcinoma of contiguous organs, is by no means infrequent. These extensions occur from the œsophagus, the larynx, the thyroid gland, the bronchial glands, and the bronchi. Ulceration is most frequent in cases progressing from the œsophagus and the larynx, and fistulous communication between the trachea and œsophagus is not rare. A carcinoma of the two tubes may attain great dimensions, sometimes imbedding the common carotid artery, the jugular vein, the pneumogastric nerve, and the pleura.[2]

Symptoms of Intra-tracheal Tumors.—There are no symptoms specially indicative of a growth in the trachea, unless it becomes large enough to interfere mechanically with respiration, and to produce intense cough, dyspnœa, and even stridor. Harsh, dry, persistent cough has in some instances preceded the labored respiration and stridor, and it is quite probable that dry, sonorous *râles* are among the earliest symptoms. The voice is sometimes much impaired in strength by reason of the limited volume of the expiratory current. A forward position of the head has sometimes a marked influence in ameliorating the intensity of the symptoms, and the recumbent position may become unendurable. The intensity of the dyspnœa depends much on the mobility, size, and location of the growth. It is sometimes suffocative. In Dr. Fifield's[3] case, a primary pedunculated growth the size of a grape, and attached to the trachea at the mouth of the bronchus, closed the left bronchus to the inspiratory current as with a pea-valve. Mackenzie[4] records a case in which a similar polypus covered the 4th, 5th, and 6th rings anteriorly, and in which death was sudden. Stallard[5] reports a case in which sudden death ensued after a fit of coughing. Quite large growths however may exist without symptoms sufficiently significant to suggest laryngoscopic examination.[6] The symptoms may simulate those of aneurism.[7]

The symptoms of sarcoma are similar to those of benign growths. Those of carcinoma embrace usually pain and the symptoms of stricture of the trachea in addition. In carcinoma by extension, these become superadded to the earlier symptoms of disease in contiguous organs, especially dysphagia, from carcinoma of the œsophagus, and dysphonia or aphonia, from pressure on the recurrent laryngeal nerves.

Diagnosis.—This is possible only by laryngo-tracheoscopy, or by inspection or palpation through a tracheal wound. It is probable that the outline of a tumor might be detected by strong transmitted illumination from the exterior (method of Massei). In the laryngoscopic image, a tumor is seen below the cricoid cartilage. If obscured by the presence of a laryngeal growth, dyspnœa continuing after removal of the latter may lead to a correct diagnosis.[8] But little can be inferred from inspection as to the nature of the growth. Should fragments be expectorated, they can be examined under the microscope. Unless there be no doubt that the growth occupies as deep a position as indicated, a laryngeal growth may be mistaken for a tracheal one. I have known a growth to be described as endo-tracheal, and as situated at the fourth or fifth ring, which had been described by myself as an endo-laryngeal growth, not below the level of the cricoid cartilage. It is necessary also to be able to exclude involutions of the trachea (see Fig. 1047, page 684), whether from aneurism or from growth outside the air-tube, giving rise to similar physical symptoms. Occasionally, the pulsation of an aneurism can be detected in the laryngoscopic image.[1]

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[1] Klebs, op. cit., Bd. ii. Abth. 1, S. 302.

[2] Wood, Brit. Med. Jour., Feb. 25, 1871, p. 196.

[3] Boston Med. and Surg. Journal, Nov. 14, 1861; cited by Gibb.

[4] Op. cit., vol. i. p. 525.

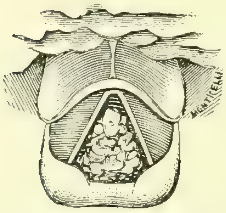
[5] Loc. cit.

[6] Tuerck, op. cit., S. 502.

[7] Delafield, loc. cit.

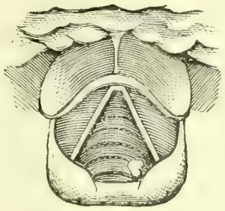
[8] Fournié, loc. cit.

Fig. 1092.



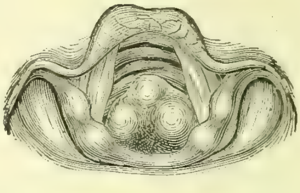
Tracheal tumor seen by laryngoscopy. (Labus.)

Fig. 1093.



The same case after evulsion of the tumor. (Labus.)

Fig. 1094.



Sarcoma of trachea. (Schroetter.)

The cases in which polypi, presumed to be tracheal, have occasionally been expectorated, such as those described by Samber[2] and by Nicholls,[3] may not have been cases of tracheal growth, as it is impossible to distinguish expectorated masses as laryngeal or tracheal.

Prognosis.—The prognosis is unfavorable. In cases not subjected to treatment, or subjected to hazardous intra-laryngeal treatment, death may take place by suffocation. In cases subjected to proper surgical procedure—tracheotomy—a benign growth may often be safely removed. The same remark is applicable, to a certain extent, to sarcomas.

Carcinoma, unless exceedingly circumscribed, is necessarily fatal. Death may take place by asthenia, by hæmoptysis, by collapse from perforation, or by gradual or sudden apnœa.

Treatment.—Despite occasional success, attempts to treat a tracheal tumor by operation through the mouth seem to me hazardous, and therefore improper. One death is recorded (see table) from an attempt to inject a solution of ferric chloride—a procedure which in more experienced hands had succeeded in shrivelling the remnants of a growth, portions of which had, at different intervals, been removed with forceps. Previous to manipulations in the successful case, local anæsthesia was produced by pencilling the larynx first with chloroform, and then, at intervals of about an hour, with a solution of morphine-acetate, ten grains to the drachm of water, until the sensibility of the part was sufficiently obtunded. This plan, at one time much in vogue in some localities, preparatory to removals of intra-laryngeal growths, seems to me in the highest degree reprehensible, for dangerous and even fatal narcotism has been reported therefrom. I have never seen the method practised, and have never cared to try it. Gerhardt is said to use colchicin with some satisfaction as a local anæsthetic. As these lines are being written, favorable reports are being published of the use of cocaine-hydrochlorate as a local anæsthetic, applied to the conjunctival mucous membrane—an agent said to have been previously employed to produce anæsthesia of the mucous membrane of the larynx.[1] Several attempts by myself to produce anæsthesia in the larynx with this agent, have failed to control spasm in the subsequent introduction of instruments, although the sensation of contact was greatly obtunded. In the pharynx and palate the effects are much better. It may be stated parenthetically that both tincture and fluid extract of coca have, during recent years, been occasionally employed by myself as well as by others,[2] to obtund sensitiveness in hyperæsthesia of the mucous membrane of the pharynx and larynx.

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[1] Cheesman, Medical Record, Sept. 22, 1883, p. 335.

[2] Philosophical Transactions, No. 398. 1727; cited by Coxe (Am. Jour. Med. Sci., O. S., vol. iii. p. 243. 1828–1829).

[3] Ibid., 1731; Coxe, loc. cit.

Mackenzie[3] records two instances in which one touch to a tracheal growth with the electric cautery-point seemed to remove all vestige of the neoplasm within a week. The fact that in the treatment of laryngeal neoplasms, mere touching with the electric cautery simply scorches the mucous membrane, renders these exceptional results too uncertain to secure approval of the method.

Similar caution is applicable to the use of forceps. The spasmodic closure of the chink of the glottis in the non-anæsthetized larynx, which almost invariably follows its passage by any instrument, must obstruct the view and hinder freedom of manipulation.

The proper method of treating a benign tracheal neoplasm is, when practicable, to incise the trachea at a point sufficiently low to expose the growth, and then to remove it by forceps, sharp spoon, or finger-nail, as may be found most efficacious. The points of implantation should then be cauterized. In the one case to which my personal experience of this measure is limited, the only difficulty encountered was from the bleeding and the spasmodic coughing which rendered the operation unpleasant. It was performed with the head hanging down so that the blood should not flow into the bronchi.

It is well known that the tracheal bifurcation can be reached through the ordinary tracheotomy incision below the isthmus, so that a tumor might readily be attacked in almost any portion of the tube; and, as was done in one of the cases recorded in the table, there seems to be no reason why the incision should not be prolonged down to the very top of the sternum when necessary.

In carcinoma, measures for relief are limited to palliative attempts to reduce suffering to a minimum. Tracheotomy below the seat of disease will afford temporary relief to dyspnœa from obstruction above the incision, and hypodermic injections of morphine will subdue pain. Surgery as yet tenders no prospect of permanent relief by exsection.

LARYNGECTOMY.

The successful exsection of the human larynx has been one of the greatest surgical surprises of the century. In the course of some experiments on dogs, instituted by Albers,[4] in 1829, to ascertain to what extent the larynx participated in respiration, he removed the entire organ from two animals. One died by hemorrhage from an accidental wound of the carotid; but the other lived for nine days, and died apparently from insufficient nourishment.[1] These experiments were wholly unassociated with any question as to the practicability of such an operation in man. Langenbeck,[2] it appears, in 1854, had made favorable mention of the procedure in his Klinik. Heuter[3] states that some years before 1870 he had entertained the idea of performing the operation upon a vigorous, middle-aged woman, with a cancroid of the mucous membrane in the neighborhood of the arytenoid cartilage; an idea which had occurred likewise to Koeberlé, in 1856,[4] and which had been both entertained and put in execution by Dr. Patrick Henry Watson, of Edinburgh, in 1866.[5] To Vincenz Czerny, of Heidelberg, however, belongs the credit of recommending the performance of this operation on the human subject, as the outcome of his own experiments on dogs.[6]

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[1] Lancet, Oct. 4, 1884; Medical News, Oct. 25, 1884, p. 457.

[2] Du Cazal, Rev. Méd. Française et Étrangère, 19 Nov., 1881, p. 751; also, Medical Record, April 7, 1883, p. 384.

[3] Op. cit., vol. i. p. 525.

[4] Graefe und Walther's Journal für Chirurgie, 1829.

Emboldened by the favorable results of Czerny's experiments, Prof. Billroth, of Vienna, deliberately undertook to perform an operation of the same kind on a man[7] in whom recurrence had taken place within four weeks of attempted extirpation of a carcinoma after splitting the larynx. After the wound healed, an artificial larynx, another device of Czerny's, constructed according to indications suggested by Gussenbauer, enabled the patient to talk with an artificial, monotonous voice. This patient died about one year after the operation, in consequence of recurrence in the cervical glands, commencing some four months after he had left the Klinik.[8]

Since this period the operation has been repeatedly performed, chiefly in cases of carcinoma. (See table, page 757.) A case of suicidal exsection of the larynx, in a woman forty-one years of age, has been recorded by Mr. R. C. Harrison.[9] Death occurred in twenty minutes.

The second table (page 768) comprises all the records of unilateral laryngectomy to which I have had access. Two cases of "partial excision of the larynx," reported by Foulis,[10] are not introduced, since they were mere exsections of the anterior portion of the cricoid cartilage, and therefore belonged to the category of resection, a much less serious operation.

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[1] Schüller, Die Tracheotomie, Laryngotomie, und Extirpation des Kehlkopfes, S. 197. Stuttgart, 1880.

[2] Ibid.

[3] Pitha und Billroth's Deutsche Chirurgie. Bd. iii. Abth. 1, Lief. 5 (Tracheotomie und Laryngotomie), S. 99.

[4] Bergen, Revue des Sciences Médicales, t. ix. p. 298; Am. Jour. Med. Sci., Jan. 1878, p. 268.

[5] Foulis, Trans. International Med. Congress, vol. iii. page 255. London, 1881.

[6] Versuche über Kehlkopf-extirpation (Wiener med. Woch., S. 559. 1871).

[7] Gussenbauer, Arch. f. klin. Chir., Bd. xvii. S. 343. 1874.

[8] Gussenbauer, cited by Schüller (op. cit., S. 198).

[9] Brit. Med. Jour., July 21, 1883, p. 115.

[10] Trans. Internat. Med. Congress, vol. iii. p. 258. London, 1881.

TABLE OF COMPLETE LARYNGECTOMIES, INCLUDING AND SUPPLEMENTING THE TABLES OF MACKENZIE, FOULIS, BLUM, AND BUROW.

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
1	Watson, Patrick Heron (Edinburgh).	1866	36	M.	Stenosis from syphilis.	Larynx and one ring of trachea.	Death in 3 weeks from pneumonia.	Foulis : Transactions International Med. Congress, vol. iii. p. 255, 1881.	Pneumonia was suspected before the operation.
2	Billroth (Vienna).	1873 Dec. 31	36	M.	Carcinoma of the larynx.	Larynx, lower third of epiglottis, part of the upper two rings of trachea.	Death from recurrence 7 months after the operation.	Archiv f. klin. Chirurgie, Bd. xvii. S. 343.	Recurrence noted at end of 4 months.
3	Heine (Prague).	1874 April 28	50	M.	Carcinoma of the larynx.	Entire larynx.	Death from recurrence 6 months after operation.	Arch. f. klin. Chir., Bd. xix. S. 584; Böhm. Corresp. Bl., 1874.	
4	Schmidt, M. (Frankfort).	1874 Aug. 12	56	M.	Epithelioma of the larynx.	Thyroid, cricoid, and both arytenoid cartilages.	Death on the fourth day from collapse.	Arch. f. klin. Chir., Bd. xviii. S. 189.	
5	Maas (Breslau).	1874 June 1	57	M.	"Adeno-fibroma carcinomatosum."	Entire larynx.	Death from pneumonia 2 weeks after operation. "On fourth day." (Blum.)	Arch. f. klin. Chir., Bd. xix. S. 507.	
6	Watson, P. H. (Edinburgh).	1874	60	M.	Epithelioma of larynx extending to left vocal band.	Larynx.	Death from pneumonia in 2 weeks.	Foulis, Trans. Inter. Med. Congress, 1881.	
7	Schönborn (Königsberg).	1875 Jan. 22	72	M.	Carcinoma of the larynx.	Entire larynx.	Death on the fourth day.	Berliner klin. Woch., 20 Sept. 1875, S. 525.	
8	Bottini (Turin).	1875 Feb. 6	24	M.	Sarcoma (partly round-celled, partly spindle-celled) of the larynx.	Entire larynx.	WELL, OCT. 7, 1884, NEARLY TEN YEARS AFTER OPERATION.	Communicazione letta innanzi la R. Academia di Medicina di Torino, 30 Aprile, 1875. Letter from Prof. F. Massei.	The operation entailed copious hemorrhage, and was followed by severe erysipelas.
9	Langenbeck (Berlin).	1875 July 21	57	M.	Carcinoma of upper part of larynx, of the epiglottis, and of the hyoid bone.	Entire larynx, hyoid bone, part of the tongue, pharynx, and œsophagus.	Death from recurrence in cervical lymphatic glands, four months after.	Berlin. klin. Woch., 1875, No. 33, S. 453; Arch. f. klin. Chir., Bd. xxi. Supplem., S. 136.	
10	Multanowski (St. Petersburgh).	1875 July 27	59	M.	Carcinoma.	Entire larynx.	Death from croupous pneumonia 3 months after operation.	Centbl. f. Chir., 1882, No. 25; and letter from Dr. A. Schmidt to Prof. Burow (Archives of Laryngology, April, 1883).	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
11	Multanowski (St. Petersburgh).	1875 Aug. 9	47	M.	Carcinoma.	Entire larynx.	Death from recurrence 2 months after operation.	Ibid.	
12	Billroth (Vienna).	1875 Nov. 11	54	M.	Diffuse carcinoma of the larynx.	Entire larynx.	Death on the fourth day from extensive broncho-pneumonia.	Billroth, Clinical Surgery, p. 133. London, 1881.	Had not been preceded by tracheotomy; wound did well, with but little febrile reaction.
13	Maas (Freiburg).	1876 Feb. 5	50	M.	Epithelioma of the larynx.	Entire larynx, with exception of the epiglottis and of a small piece of the cricoid cartilage.	Death from recurrence 6 months after the operation.	Arch. f. klin. Chir., Bd. xx. S. 535. Private communication from operator to Dr. Foulis (Trans. Int. Med. Cong., 1881).	Recurrence in posterior portion of tongue about three months after operation. Death by hemorrhage from the ulcerated mass.
14	Gerdes (Jever).	1876 Mar. 30	76	M.	Carcinoma.	Entire larynx.	Death on the fourth day from collapse.	Arch. f. klin. Chir., Bd. xxi. S. 473.	
15	Reyher (Dorpat).	1876 May	60	M.	Carcinoma of the vocal bands.	Entire larynx, with exception of epiglottis.	Death on the eleventh day from hypostatic pneumonia.	St. Petersburgher med. Woch., Nos. 17 und 18, 1877.	
16	Watson, P. H. (Edinburgh).	1876	60	F.	Epithelioma of larynx, with enlargement of some adjacent glands.	Larnyx and enlarged glands.	Death in one week from pulmonary embolism.	Letter from operator to Dr. Foulis.	The lingual and facial veins were cut in the operation.
17	Kosinski (Warsaw).	1877 Mar. 15	36	F.	Epithelioma of the larynx, with perforation of the skin.	Entire larynx.	Death from recurrence 9 months after operation.	Centbl. f. Chir., No. xxvi. 1877, S. 401. Private communication from operator to Dr. Foulis.	
18	Foulis (Glasgow).	1877 Sept. 10	28	M.	Sarcoma; "partly papilloma, partly spindle-celled sarcoma."	Entire larynx, with exception of superior cornua of thyroid cartilage and half the arytenoid cartilages.	Death from tracheal and pulmonary phthisis, March 1, 1879.	Lancet, Oct. 13, 1877, and March 29, 1879.	
19	Wegner (Berlin).	1877 Sept. 16	52	F.	Carcinoma of the larynx, size of walnut, originating from right ventricle.	Entire larynx, with epiglottis, but leaving lower half of the cricoid cartilage.	WELL, APRIL 12, 1878.	Verh. der Deut. Gesellsch. f. Chir., 1878. Private communication from operator to Dr. Foulis.	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
20	Bottini (Turin).	1877 Aug. 29	48	M.	Epithelioma of the larynx.	Entire larynx and portion of œsophagus.	Death on the third day from double pneumonia.	Annales des Maladies de l'Oreille et du Larynx, 1 Juillet, 1878; Centbl. f. Chir., 1878.	Performed "bloodlessly" with galvano-cautery blade.
21	Bruns, Victor von (Tübingen).	1878 Jan. 29	54	M.	Epithelioma of the larynx (of 5 years' duration).	Entire larynx.	Death from recurrence 9 months after operation.	Wien. med. Presse, 17 Nov. 1878. Communication from Prof. Paul Bruns to Dr. Foulis.	Preliminary tracheotomy not performed. Collapse after operation, and hyperpyrexia for a week. Voice-tube employed in five weeks.
22	Rubio (Madrid).	1878 May 11	41	M.	Perichondritis of the thyroid cartilage, with necrosis.	Entire larynx.	Death on the fifth day from marasmus.	Observacion clinica, etc. Real Academia de Med., Madrid, 1878.	
23	Czerny (Heidelberg).	1878 Aug. 24	46	M.	Lympho-sarcoma in and under vocal bands, and perforating the thyroid cartilage; also involving the neighboring glands.	Entire larynx, and the diseased glands.	Death from recurrence 15 months after operation (in high fever with right-sided pleurisy), Nov. 30, 1879.	Letter from operator to Dr. Foulis. Schüller, Die Tracheotomie (Billroth und Lücke's Deutsche Chirurgie, H. 37, S. 200). Berlin. klin. Woch., No. 26, 1882. Reprint (Maurer).	Repeated removals of recurring masses (5 operations). Suppuration of extensive glandular metastases. Resection of common jugular vein, of common, internal, and external carotid arteries, and of pneumogastric nerve. Paralysis. Extremely wretched condition of patient.
24	Billroth (Vienna).	1879 Feb. 27	43	F.	Epithelioma of pharynx, larynx, and thyroid gland.	Entire larynx, with part of pharynx and œsophagus.	Death during seventh week from passage of bougie into mediastinum.	Private communication from operator to Dr. Foulis.	
25	Gussenbauer, (Prague).	1879 May 24	24	M.	Tuberculous tumor supposed to have been carcinoma.	Entire larynx.	Death 2 months after operation, from tuberculosis pulmonum.	Centralbl. f. Chir., No. 45, 1882.	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
26	Macewen, Wm. (Glasgow).	1879 July 31	56	M.	Carcinoma of larynx and upper end of gullet; also a glandular mass at left side of neck.	Larynx, part of gullet, and the glandular mass.	Death in 3 days from pneumonia.	Foulis, Trans. Int. Med. Congress, 1881.	
27	Caselli, Azzio (Reggio-Emilia).	1879 Sept. 20	19	F.	Sarcoma of larynx, pharynx, palate, and base of tongue.	Entire larynx, pharynx, base of tongue, soft palate, and tonsils.	WELL, AUGUST, 1881 (probably still living).	Bul. del Scien. Med. Bologna, tomo v. 1880. Centbl. f. Chir., 1880; Caselli's Reprint, Bologna, 1880. Caselli's statement at meeting Int. Med. Cong., London, 1881.	Operation occupied more than 3 hours, was largely done with the galvanocaustic blade, and was attended with but little hemorrhage.
28	Lange, F. (New York).	1879 Oct. 12	74	M.	Sarcoma of larynx involving the gullet.	Larynx, right cornu of hyoid bone, part of gullet.	Death from asthenia nearly seven months after operation. Recurrence.	Archives of Laryngology, N. Y., 1879, p. 36.	
29	Multanowski (St. Petersburgh).	1879 Dec. 4	60	M.	Carcinoma.	Entire larynx.	Death on fifth day from pneumonia.	Centralbl. f. Chir., No. 25, 1882. Letter from Dr. A. Schmidt to Prof. Burow (Arch. Lar., April, 1883).	
30	Langenbuch.	1879	An aged female		Carcinoma.	………………	Death on third day from collapse.	Verh. der Deutsche Ges. f. Chir., Bd. x.	Only found in Blum's list (Arch. Gén. de Méd., tome ii. 1882, p. 79).
31	Reyher, Carl (St. Petersbugh).	1880	48	M.	Carcinoma.	Larynx.	Death on seventh day from septic bronchopneumonia.	Wolner's Med. Jour., 1880, H. 1. Letter from operator to Dr. Foulis.	
32	Thiersch (Leipsic).	1880 Feb. 26	36	M.	Carcinoma.	Entire larynx and two rings of trachea.	Death, Aug. 19, 1882, eight days after a second operation necessitated by recurrence. Duration of life after extirpation of larynx, TWO AND A HALF YEARS.	Deutsch. Ztschr. f. Chir., Bd. xvi. S. 149. Centbl. f. med. Wiss., 23 Sept. 1882. Revue Mens. de Laryn., No. 82, p. 350, but accredited to Landerer. Letter from operator to compiler, Nov. 8, 1883.	Tracheotomy, Sept. 27, 1879. Laryngotomy for access to growths, Feb. 3, 1880. Recurrence first noted early in '82. Arterial bleeding; ligature of carotid; new bleeding; trial made of extirpation. Diffuse carcinoma to below the sternum.

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
33	Thiersch (Leipsic).	1880 April 15	52	M.	Carcinoma.	Entire larynx.	Alive and well, Nov. 8, 1883, three years and seven months after operation.	Ibid.	Tracheotomy, Mar. 2, 1880.
34	Kocher (Berne).	1880 July	...	...	Lupus.	....	Death in 1883, from general tuberculosis.	Letter from operator Sept. 24, 1883.	
35	Novaro	1880 Aug. 19	63	M.	Carcinoma.	Entire larynx.	Recurrence in four months. Excision of right lobe of thyroid gland and part of pharynx (Jan. 14, 1881). Death from hemorrhage on 11th day.	Giorn. di R. Acad. di med. di Torino, tomo xxix. p. 34, 1881. Arch. Ital. di Lar., Anno I., p. 75, 1881–1882.	Low tracheotomy, July 14, 1880.
36	Czerny (Heidelberg).	1880 Oct. 11	47	M.	Epithelioma of larynx and superjacent soft parts.	Larynx and soft tissues in front of it.	Death from exhaustion and severe hemorrhage 5 months (Mar. 25, 1881) after.	Letter from operator to Dr. Foulis. Berl. klin. Woch., No. 26, 1882. Reprint (Maurer).	Extensive recurrence in throat.
37	Hahn (Berlin).	1880 Oct. 23	67	M.	Carcinoma.	Larynx, all except a portion of the thyroid cartilage.	Free from recurrence 2 years after operation.	Letter from operator to Prof. Burow (Archives of Laryngology, April, 1883).	Possibly Case 5 of table on p. 768.
38	Thiersch (Leipsic).	1880 Nov. 10	45	F.	Carcinoma of pharynx and larynx.	Larynx and part of pharynx.	Death from recurrence in 4 months (March 16, 1881).	Deutsch. Ztsch. f. Chir., Bd. xvi. S. 149. 1881.	Tracheotomy, Oct. 17, 1880. Recurrence noted within six weeks after operation.
39	Bircher, H. (Aarau).	1880 Dec. 3	49	F.	Scirrhus of the thyroid gland, involving the larynx.	Thyroid gland excised; 6 months after, the cancer recurred, and the larynx was excised with part of the gullet.	Death in 16 days from pneumonia and gangrene of the lung.	Letter from operator to Dr. Foulis (Trans. Int. Med. Congress, 1881).	
40	Pick (London).	1881 Jan. 16	39	M.	Epithelioma of larynx (preceded by papillomata).	Larynx and epiglottis.	Death in 5 days from pleurisy and pericarditis.	Lancet, April 2, 1881, p. 541. Brit. Med. Journ., April 9, 1881, p. 562.	
41	Thiersch (Leipsic).	1881 Jan. 17	57	F.	Carcinoma of pharynx and larynx.	Entire larynx and part of pharynx.	Death on seventh day from secondary infectious pneumonia.	Deutsch. Ztsch. f. Chir., Bd. xvi. S. 149. 1881.	Tracheotomy, Dec. 9, 1880.

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
42	Toro (Cadiz).	1881 March 9	...	...	Epithelioma of larynx.	Hyoid bone, base of tongue, and larynx.	Death on fourth day from pulmonary emphysema.	Med. Record, Aug. 6, 1881, p. 167.	
43	Winiwarter, (Liège).	1881 April	55	F.	Carcinoma.	Entire larynx.	ALIVE AND WELL, July 1884, THREE YEARS AND FOUR MONTHS AFTER OPERATION.	Clinique Chir. Univ. Liège. Monatschr. f. Ohrenheilk, No. 9, 1882. Burow's list. Letter from operator to compiler, Oct. 7, 1884.	
44	Foulis (Glasgow).	1881 April 30	50	M.	Epithelioma of larynx (preceded by papillomata).	Larynx.	WELL AND STRONG, Aug. 1881.	Brit. Med. Journ., May 7 and June 11, 1881; Trans. Int. Med. Cong., 1881.	
45	Czerny (Heidelberg).	1881 May 12	47	M.	Epithelioma.	Larynx and upper two rings of trachea.	Death from recurrence 18 months after operation (Nov. 1882).	Letter from operator to Dr. Foulis. Verbal report to Int. Med. Cong., London, 1881. Letter from operator to compiler.	
46	Reyher, Carl (St. Petersburgh).	1881 May 14	57	M.	Carcinoma.	Larynx.	Death on fifth day from septic broncho-pneumonia.	Letter from operator to Dr. Foulis (Trans. Int. Med. Congress, 1881).	
47	Kocher (Berne).	1881 May 16	59	M.	Carcinoma.	Entire larynx, except a piece of the cricoid cartilage.	Death in 1883, say TWO YEARS AFTER OPERATION, from cancerous disease of abdomen. NO LOCAL RECURRENCE.	Letter from operator to Prof. Burow (Arch. Laryn., N. Y., April, 1883). Letter from operator to compiler, Sept. 1883.	Patient wears a self-made artificial epiglottis to overcome choking in deglutition, result of excision of epiglottis.
48	Tilanus (Amsterdam).	1881 May	51	M.	Epithelioma.	Entire larynx.	Death in 36 hours from collapse.	Centbl. f. Chir., No. 34, 1882.	
49	Gussenbauer (Prague).	1881 May 19	48	M.	Carcinoma.	Entire larynx.	WELL, MORE THAN 2 YEARS AFTER OPERATION. Doing duty as a riding master.	Letter from operator to Prof. Burow (Arch. Laryn., N. Y., April, 1883). Prag. med. Woch., No. 31, 1883.	
50	Volker (Brunswick).	1881 May 28	44	F.	Carcinoma epithelioides.	Entire larynx.	Death from suffocation 5 months after operation.	Academisch Proefschrift, S. 84 und 112. Amsterdam, 1882.	Suffocated while patient had withdrawn canula to cleanse it.

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
51	Albert (Vienna).	1881 July 6	45	M.	Carcinoma, almost filling right half of larynx.	Entire larynx, except epiglottis; also small section of adherent œsophagus.	Death on eighth day from diffuse bronchitis and lobular pneumonia.	Wien med. Presse, Bd. xxii. S. 1373. 1881.	On 13th, hemorrhage from internal carotid, arrested by ligature above and below point of erosion. Collapse same evening; death next day.
52	Hahn (Berlin).	1881 Aug. 13	46	M.	Carcinoma.	Entire larynx.	Death in 25 days from putrid bronchitis.	Letter from operator to Prof. Burow.	
53	Margary (Turin).	1881 Sept. 29	36	F.	Epithelioma of œsophagus and larynx	Larynx, first ring of trachea, thyroid body, part of pharynx, and œsophagus.	Death by hemorrhage, March 25, 1882.	Arch. Ital. di Lar., 1881–1882, pp. 121, 172.	Recurrence at end of three months.
54	Gussenbauer (Prague).	1881 Oct.	62	M.	Carcinoma.	Entire larynx.	STRONG AND WELL 21 MONTHS AFTER OPERATION.	Prag. med. Woch., No. 31, 1883.	
55	Reyher, Carl (St. Petersburgh).	1881 Oct. 10	73	M.	Carcinoma.	Larynx and upper three rings of trachea.	Death from recurrence 9 months after operation.	St. Petersb. med. Ztschr., No. 28, 1882. Letter from operator to Prof. Burow.	
56	Reyher, Carl (St. Petersburgh).	1881 Oct. 10	65	M.	Carcinoma.	Larynx.	Death on seventh day from septic pneumonia.	Ibid.	
57	Schede, M. (Hamburg).	1881 Nov. 4	54	M.	Cancroid.	Larynx, hyoid bone, and thyroid gland.	Recurrence 6 mos. after operation, too extensive for extirpation. Date of death not mentioned.	Deutsche med. Woch., No. 33, 1882, S. 45. Letter from operator, Sept. 1884.	
58	Reyher, Carl (St. Petersburgh).	1882 April 7	55	M.	Carcinoma epithelioides.	Entire larynx, pharynx, and parts of œsophagus.	Death 14 days after operation from exhaustion.	Letter from operator to Prof. Burow.	
59	Kocher (Berne).	1882 May 13	54	M.	Carcinoma.	Entire larynx and carcinomatous glands.	Recurrence in lymphatic glands 7 months after operation. STILL LIVING WITHOUT LOCAL RECURRENCE, Sept. 24, 1883, 16 MONTHS AFTER OPERATION.	Letter from operator to Prof. Burow. Letter from operator to compiler.	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
60	Whitehead, Wm. (Manchester).	1882 May 27	46	M.	Epithelioma of right vocal band and parts subjacent, as far down as upper portion of trachea.	Thyroid and cricoid cartilages and two rings of trachea, leaving epiglottis intact.	Well, January 31, 1883. Probably still alive.	Lancet, Nov. 4, 1882, p. 741. Letter from operator to compiler, dated Jan. 31, 1883.	
61	Von Bergmann (Würzburg).	1882 June 12	54	M.	Carcinoma. (Adeno-sarcoma?)	Entire larynx.	Recurrence, Feb. 1883; death (Zesas).	Sitzungsb. Würzburg Phys. Gesell., S. 47–56, 1882. Deutsche med. Woch., No. 35, 1882. Centbl. f. Chir., 19 Aug. 1882.	
62	Burow (Königsberg).	1882 July 7	44	M.	Carcinoma.	Entire larynx without epiglottis.	Death from sudden suffocation 4½ months after operation.	Archives of Laryngology, April, 1883.	
63	Kocher (Berne).	1882 Sept. 28	43	M.	Carcinoma.	Entire larynx and a portion of œsophagus	Alive at last account.	Volkmann, Samml. klin. Vorträge, No. 224, S. 1944. Letter from operator, Sept. 24, 1883.	
64	Maydl (Vienna).	1882 Aug. 31	50	M.	Carcinoma.	Larynx, except cricoid cartilage. Excision of a gland, size of a dove's egg.	Alive and well, 16 mos. after operation.	Wiener med. Presse, Bd. xxiii. S. 1672. Wien. med. Woch., No. 44, 1882. Wien. med. Presse, Bd. xxv. S. 367. 1884.	
65	Ruggi.	1882	10	M.	Papilloma of larynx.	Entire larynx.	Alive, Oct. 7, 1884.	Centbl. f. Chir., No. 45, 1882. Raccoglitore Med., t. xviii. p. 36. 1882. Letter from Prof. F. Massei.	"Recovery in 28 days." (Burow's list.)
66	McLeod (Calcutta).	1882 Nov. 15	35	M.	Papilloma of larynx. (Tubercular?)	Entire larynx and thyroid gland.	Death at 5½ months.	Ind. Med. Gaz., vol. xviii. pp. 24–26, 1883. Lancet, Sept. 15, 1883. Jour. Am. Med. Assoc., Oct. 27, 1883, p. 487.	Autopsy showed miliary tubercles in both lungs, small vomicæ in right lung; a pint of fluid in the left pleura. The growth sprang from the interior of the larynx.
67	Hodgen (St. Louis).	......	...	...	....	....	Death in 4 days.	Letter from Dr. W. C. Glasgow, St. Louis.	

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No	Operator.	Date.	Age	Sex	Disease.	Parts removed	Result.	Reference.	Remarks
68	V. Holmer (Copenhagen).	1882 Mar. 15	57	...	Epithelioma.	Larynx, except epiglottis.	Death in 7 months from recurrence.	Reprint from Hospitals-Tidende, Copenhagen, 1883.	
69	V. Holmer (Copenhagen).	1882 July 18	63	M.	Epithelioma.	Larynx, epiglottis, and part of pharynx.	Death in 4 months from recurrence.	Reprint from Hospitals-Tidende, Copenhagen, 1883.	
70	Maydl, Karl (Vienna).	1883 Mar. 27	45	M.	Carcinoma.	Entire larynx and upper part of trachea.	Death 5th day. Severe arterial hemorrhage.	Wien. med. Presse, 24 März, 1884, S. 364.	Tracheotomy proved insufficient to avert impending death on account of rapid extension of disease. The autopsy showed extensive degenerative lesions, which might have caused death independently of the operation. A large part of the operation was done with the thermocautery, a possible factor in the secondary hemorrhages.
71	Kocher (Berne).	......	...	...	Carcinoma ?	....	PATIENT ALIVE, with glandular involvement without local recurrence, Sept. 24, 1883, SEVERAL MONTHS AFTER OPERATION.	Letter from operator to compiler.	Unpublished.
72	Winiwarter.	1882 Sept.	46	M.	Carcinoma.	Entire larynx except cricoid cartilage. Several lymphatic glands.	Recurrence April, 1883, seven months after operation.	Letter from operator to compiler, Oct. 7, 1884.	Unpublished.
73	Winiwarter.	1883 Oct.	50	M.	Carcinoma.	Entire larynx, part of pharynx, several lymphatic glands. Resection of internal jugular vein.	Death in ninth week from inanition; the wound perfectly granulated.	Ibid.	Unpublished.

TABLE OF COMPLETE LARYNGECTOMIES.—*Continued.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
74	Preetorius, A.	1883 July 28	54	F.	Carcinoma.	Larynx, except lower half of cricoid cartilage. Two enlarged glands.	No RECURRENCE, Nov. 1883.	Deutsche Zeitsch. f. Chir., Bd. xix. S. 621. Centbl. f. Chir., 21 Juni, 1884.	Preliminary tracheotomy 14 days before operation.
75	Leisrink, H.	1883 Aug.	72	M.	Carcinoma.	Entire larynx.	Death in 4 months from croupous pneumonia.	Berlin. klin. Wochensch., 4 Feb. 1884.	Preliminary tracheotomy.
76	McLeod (Calcutta).	1883 Sept. 19	54	M.	Carcinoma?	Entire larynx with tumor of pharynx and right lobe of thyroid gland; indurated lymphatic glands.	Death on fifth day from secondary hemorrhage.	Lancet, April 26, 1884, p. 750.	Microscopic report suggests sarcoma. Embryonic tissue; fusiform and polynucleated cells.
77	Novaro.	1883 Oct. 1	54	M.	Carcinoma originating in right pyriform sinus.	Entire larynx, thyroid body, and part of the wall of the pharynx.	Death in 1 month from croupous pneumonia.	Gaz. deg. Osp., 9 Dec. 1883; Letter from Prof. F. Massie.	No preliminary tracheotomy. Trendelenburg's canula not employed.
78	Jones, Thos. (Manchester).	1884 April 26	44	M.	Carcinoma.	Entire larynx, first ring of trachea, anterior and lateral walls of pharynx.	Well, June 14, 1884, one and a half mos. after operation.	Lancet, Aug. 2, 1884, p. 191; Med. News, Aug. 23, 1884, p. 21.	
79	Hahn, E. (Berlin).	?	43	...	Carcinoma.	Larynx, part of œsophagus, and neighboring glands.	Death in 4th week from suppurative bronchitis and pneumonia.	Beilage zum Centralblatt für Chirurgie, 1884, No. 23, S. 54.	Possibly same case as No. 52.
80	Hahn, E.	?	48	...	Carcinoma.	Larynx, part of œsophagus, and neighboring glands.	Death in 5th week from suppurative bronchitis and pneumonia.	Ibid.	
81	Hahn, E.	1884 Jan.	58	...	Carcinoma.	Entire larynx.	Living three months after operation.	Ibid.	
82	Schede (Hamburg).	1884	69	M.	....	....	....	Letter from operator Sept. 18, 1884.	Prognostics very favorable.
83	Schede.	1884	58	F.	....	....	....	Ibid.	
84[1]	Durante (Rome).	1884?	...		Carcinoma. "Epithelioma."	....	Death in two or three days.	Letter from Prof. F. Massei, of Naples, Sept. 10, 1884.	Communicated to the Medical Society of Rome.

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[1] As the particulars of cases numbered higher than 84 were not received until the others were in type, the chronological order is not preserved. I desire to express my thanks to Mr. Whitehead, and to Profs. Czerny, Gussenbauer, Holmer, Kocher, Massei, Schede, Thiersch, and Winiwarter for their kind letters.

TABLE OF COMPLETE LARYNGECTOMIES.—*Concluded.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
85	Novaro.	1882 Jan.	68	M.	Carcinoma.	Entire larynx and upper rings of trachea.	Sudden death March 8, 1883. No recurrence.	Letter from Prof. Massei, Oct. 7, 1884.	Crico-tracheotomy in haste Sept. 12, 1881; thyrotomy and removal by scraping Dec. 30, 1881.
86	Novaro.	1882 July 26	52	M.	Carcinoma.	Entire larynx.	ALIVE WITHOUT TRACE OF RECURRENCE OCT. 7, 1884, NEARLY 2 YEARS and 3 MONTHS AFTER OPERATION.	Ibid.	Tracheotomy in haste April 19, 1882. A nodule the size of a walnut removed Nov. 8, 1882.
87	Novaro.	1882 Aug. 18	72	M.	Carcinoma.	Entire larynx.	Sudden death by suffocation April 19, 1883. Pen (quill?) found in trachea. It had been used for cleaning tube. No trace of recurrence.	Ibid.	Low tracheotomy June 11, 1882.
88	Gussenbauer.	1883 Feb. 6	63	M.	Carcinoma.	The cartilages and their muscles; the epiglottis, with the mucous membrane at the top of the larynx in connection with the aryteno-epiglottic folds, being retained.	Well six months after operation.	Prager med. Woch., No. 31, 1883.	To try and avoid laryngectomy, tracheotomy had been performed the day before, and had been immediately followed by thyrotomy.
89	Bergmann (Berlin).	1883	...	M.	Carcinoma.	....	Death from pneumonia four days after operation.	Zesas, Arch. f. klin. Chir., Bd. xxx. H. 3, S. 672. 1884.	
90	Vogt (Greifswald).	1884 Feb.	29	F.	Carcinoma.	....	Death from exhaustion seven days after operation.	Mittheilungen aus der chir. Klinik zu Greifswald. Cited by Zesas (loc. cit.).	
91	Holmes (London).	1884 May 26	63		Epithelioma.	Entire larynx except left half of cricoid cartilage. Free resection of pharynx.	Death from collapse in forty hours.	British Med. Journ., Oct. 25, 1884, p. 809.	A mass outside the larynx, reaching to the tonsil, could not be fully removed.

TABLE OF UNILATERAL LARYNGECTOMIES.

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
1	Billroth (Vienna).	1878 July 7	50	M.	Unilateral carcinoma from left vocal band to cricoid cartilage.	Left half of larynx and portion of right vocal band.	Alive June 23, 1879, but disease had commenced at six months in the cervical glands, with subsequent local recurrence.	Mackenzie, op. cit., vol. i. p. 348; Schüller, op. cit., S. 199, 211.	The patient was able to speak, without artificial aid, in a dull but distinct voice, and was able to take part in committee work.
2	Gerster (New York).	1880 Mar. 5	50	M.	Sarcoma of right part of pharynx, larynx, and base of tongue.	Right half of hyoid bone, larynx, and pharynx, right tonsil, epiglottis, and part of base of tongue.	Death from pleurisy, Mar. 9, 1881, one year after operation. No recurrence.	Archives of Laryngology, vol. i. p. 124. 1880. Letter from operator to Dr. Foulis. Foulis's list.	
3	Reyher, Carl (St. Petersburg).	1880 Mar. 9	57	M.	Carcinoma.	Left half of larynx.	No recurrence fourteen months after operation.	Letter from operator to Dr. Foulis. Foulis's list.	
4	Caselli.	1880 Nov. 9	7	M.	Enchondroma of neck.	A large tumor and right ala of thyroid cartilage.	Death in two days.	Pamphlet by Dr. Caselli. Foulis's list.	
5	Hahn (Berlin).	1880	67	...	Carcinoma.	Half of larynx.	Patient living three and a half years after operation; no recurrence.	Beilage zum Centralbl. f. Chir. No. 23, 1884, S. 55. Lond. Med. Record, Aug. 15, 1884.	Probably the same case as No. 37 in table of complete laryngectomies.
6	Schede (Hamburg).	1882 Oct. 19	...	M.	Infiltrating cancroid.	Right half of larynx; epiglottis not included.	Patient living eighteen months after operation.	Ibid.	Patient (a dentist) speaks so well without apparatus that his patients do not notice his defect. A cicatricial fold does duty for the lost vocal band.
7	Hahn.	1883	54	...	Carcinoma.	Half of larynx.	Patient living nine months after operation; no recurrence.	Ibid.	

TABLE OF UNILATERAL LARYNGECTOMIES.—*Concluded.*

No.	Operator.	Date.	Age.	Sex.	Disease.	Parts removed.	Result.	Reference.	Remarks.
8	Wagner, Clinton (New York).	1883 Feb. 22	53	M.	Epithelioma (in recurrence).	Right half of larynx and right half of first ring of trachea.	Death from collapse on twelfth day.	Archives of Laryngology, p. 130. 1883.	The growth appeared first as a papilloma (microscopical examination). Two thyrotomies were performed. See Arch. Lar., p. 51. 1883; Medical News, Feb. 3, 1883.
9	Winiwarter (Liège).	1883 Dec.	18	M.	Perichondritis with marked stenosis.	Right half of larynx, leaving the mucous membrane.	PATIENT LIVING TEN MONTHS AFTER THE OPERATION.	Letter from operator, Oct. 7, 1884.	Patient speaks without apparatus in a hoarse voice, audible in a large room.
10	Küster.	?	50 ?	M.	Sarcoma of one vocal band.	One side of the larynx.	Recovery.	Beilage zum Centralbl. f. Chir. No. 23, 1884, S. 57.	Repeated endolaryngeal operations; vocal band excised; rapid recurrence; then the excision of one-half of the larynx.
11	Id.	?	?	?	?	do.	do.	Ibid.	Operator mentions that he has had these three cases, without giving details.
12	Id.	?	?	?	?	do.	do.	Ibid.	
13	Id.	?	?	?	?	do.	Death.	Ibid.	

From the records referred to in the first of the above tables, and from study of some of the reports in detail, it appears evident that complete laryngectomy can be performed without sacrifice of life, but that every operation places life in peril; and that a large number of the patients succumb within a period so brief, that their early death is attributable to the operation and to nothing else. Of the deaths reported, 26 occurred within the first eight days, and 5 more within the second eight days—more than one-third of all the patients subjected to laryngectomy having thus succumbed within little more than a fortnight.

Death within the first few days occurs from shock, from hemorrhage, or from pneumonia. Very few have succumbed to shock, and only two to hemorrhage; but very many have perished from pneumonia. The occurrence of pneumonia is largely attributed to the escape of food, blood, and morbid products into the air-passages, although every available precaution has been taken to prevent this by firmly tamponning the wound with antiseptic plugs. If an inference may be suggested from what I have observed in various other operations upon the neck, it is that surgical interference of any kind in the cervical region entails a risk of pneumonia, even though the air-passage be not opened. I have seen it follow extirpation of the thyroid gland, extirpation of neoplasms, and even mere exploratory incision. The reduction of temperature to which the pneumogastric nerve is subjected, may lead to pneumonia, especially when it has been rendered additionally sensitive by manipulations within the wound. Some laryngectomies have consumed from one to three hours in their performance—an ordeal to the pneumogastric nerve quite sufficient, to my mind, to account for an early pneumonia, independently of direct sepsis.

The period of danger from pneumonia does not seem to exceed two weeks, unless the conditions are exceptional. This important fortnight of tribulation safely bridged, the life of the patient may be regarded as tolerably secure up to the fourth month. Then death from recurrence begins to be imminent, and, according to circumstances, will take place within an additional period varying from a few weeks to several months, or to more than a year.

Complete laryngectomy involves great risk of death by pneumonia, future respiration through an artificial aperture, temporary nourishment by the stomach-tube, and possibly utter inability to speak without the aid of an artificial substitute for the larynx, adjusted to the tracheal canula.

Unilateral laryngectomy does not necessarily involve dependence upon any of these mechanical aids.

Indications for the Operation.—As will be seen from the preceding tables, of some ninety complete exsections of the larynx, seventy-eight or eighty have been performed for carcinoma,[1] four for sarcoma, one for lymphosarcoma, two for papillomata, one for lupus, one for perichondritis, and one for cicatricial syphilitic stenosis. Of the thirteen unilateral exsections, six have been performed for carcinoma, two for sarcoma, and one each for perichondritis and for enchondroma of the neck. The disease in the remaining three has not yet been recorded.

It would be desirable to select for special consideration the operations upon carcinomas strictly intrinsic, and contrast the final results with the final results in similar cases let alone or subjected to palliative tracheotomy; and to make a similar study of the comparative results in carcinomas which have involved adjacent structures and lymphatic glands. Prof. Czerny writes me that the condition of some of his tracheotomized patients, in hopeless cases, was much more deplorable than the condition of those subjected to laryngectomy, who were, at least, entirely free from pain. It is likewise contended by some observers that, as tracheotomy does not relieve the dysphagia, this symptom is an additional reason for preferring the risks of laryngectomy.

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[1] Included among these are the cases in which the histology of the tumor was doubtful, since the operations were undertaken under the opinion that the disease was carcinomatous.

It is hard to comprehend the necessity for sacrificing the whole of the larynx in cases of polypi or of papillomata, however extensive, or in cases of perichondritis and of cicatricial stenosis, whether syphilitic or otherwise, diseases for the treatment of which surgery offers resources less extreme.

It seems to me that the indication for complete laryngectomy should be restricted to sarcoma, to intrinsic carcinoma, and possibly to circumscribed extrinsic carcinoma, which has not extended to adjacent structures or involved the lymphatic glands. In diffuse carcinoma extending beyond the larynx, it seems to be contra-indicated. Laryngeal carcinoma is often so long strictly intrinsic, and extrinsic carcinoma often so long unassociated with lymphatic involvement, that early operation certainly offers considerable hope of its complete removal, the more that recurrence after extirpation of the larynx has been found more frequent in the lymphatic glands than in the tissues from which the exsected structures have been severed. But inasmuch as an early laryngectomy may directly rob the patient of an important remnant of life, the responsibility of the surgeon who undertakes the operation is proportionately great.

When the disease is strictly unilateral, the indication is for unilateral laryngectomy—an operation much less serious than excision of the entire larynx, and apparently no more likely to be followed by recurrence, whether in the retained half of the larynx, in adjoining tissues, or in the lymphatic glands.

The Operative Procedure.—Undoubtedly always a severe operation, the severity of laryngectomy varies with the physical condition of the patient, the extent of the disease, the circumstances under which the operation is performed, and the complications which may follow. The operation is not necessarily a bloody one. While Bottini[1] has shown that a bloodless operation is practicable with the electric cautery, Langenbeck[2] has proved that not only may the entire larynx be removed by ordinary surgical methods without much bleeding, provided that the precaution be taken to secure every vessel before it is divided, but, in addition, the submaxillary glands from both sides, the hyoid bone and portions of the tongue, the pharynx, and the œsophagus. Thus, in the instance referred to, forty-one ligatures were employed, securing, among other vessels, both external carotids, the linguals, the external maxillaries, the superior thyroids, and the superior and inferior laryngeals.

Whether the removal of the larynx is to be effected from above downwards, or in the reverse direction, will depend upon the complications of the case, and on the preferences of the surgeon. Removal from above downward is the more tedious. To some operators it appears to be the safer plan, inasmuch as it effectively avoids all risk of escape of blood and other matters into the tracheal extremity of a severed windpipe during the important stages of the dissection; for the severance of the larynx from the trachea is the last step of the procedure instead of the first, and may be delayed until all hemorrhage is under control. The opposite plan is said to possess the advantage, that, the trachea being taken care of in the first instance, the operator can proceed more rapidly, and be relieved from all anxiety as to the entrance of blood into the air-passage. Being without personal experience in the operation, it is impossible for me to do more than express a theoretical preference for the former plan. Splitting the larynx before exsection has been occasionally practised, but does not appear to be in much favor. Another mooted point concerns the disposition to be made of the epiglottis. Independent of any question as to the likelihood of carcinoma recurring in this structure, its retention, according to some operators, does not appear requisite for any purpose. The larynx being removed, the ostensible functions of the epiglottis seem to be better performed by the root of the tongue. A retained epiglottis interferes, too, with the adjustment of an artificial larynx. On the other hand, its retention is said to guard to a certain extent against the descent of food into the air-passage, whether natural or artificial. The weight of testimony seems to indicate the propriety of sacrificing the epiglottis in all cases of carcinoma, and in all others in which an artificial larynx is to be used.

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[1] Annales des Maladies de l'Oreille, du Larynx, etc., 1 Juillet, 1878, p. 182.

[2] Berlin. klin. Woch., No. 33, 1875, S. 453.

Under special conditions even more tissue may be saved. Thus Gussenbauer,[1] in his fourth case, spared the mucous membrane at the top of the larynx, "in its connection with the ary-epiglottic ligament and the epiglottis," thus limiting the exsection to the cartilages and their muscles. In this way he hoped to prevent descent of the top of the œsophagus. The patient was able to drink his coffee on the third morning without any escape of the liquid externally, and to bear the introduction of an artificial larynx on the fourteenth day.

In the absence of personal observation, the description of the operative procedure here given is only a dead-house and library study, and lacks the precision and confidence of an operator. Yet it may be said that while its principal features are common to all laryngectomies, individualities are presented so frequently as to necessitate departures which are undeterminable beforehand.

When at all practicable, a low tracheotomy should be performed two weeks or longer before the extirpation. Several important objects are accomplished thereby. The patient will have got accustomed to breathing through a mechanical appliance. His general strength will have become invigorated by increased facility in respiration. He can more conveniently and readily be anæsthetized through the artificial opening. The trachea will have become adherent to the integument, and will require no artificial support to prevent its descent when the larynx is severed from it. The lungs having become accustomed to air received through an artificial opening, pneumonia from this source will be less likely to follow.

Gussenbauer, however, does not deem it essential that tracheotomy should long precede the laryngectomy, and considers that a tracheal wound, such as is made in a low tracheotomy, when in the immediate vicinity of a laryngectomy wound, can only be regarded as a complication. Although admitting that this objection does not apply to the wound of a high tracheotomy, which eventually unites with the lower end of the laryngectomy wound, he says that the tissues in the middle line become so infiltrated and so conglomerated that they are less readily recognized, and that their condition may complicate the detachment of the soft tissues and make hemorrhage more serious. He believes that, as the rule, high tracheotomy with horizontal severance of the trachea, as the initial step in the actual laryngectomy, fully suffices to facilitate undisturbed completion of the operation, and to allow secure fixation of the trachea by sutures.

Should the operation be performed without a preliminary tracheotomy some time previous, or immediately preceding, the trachea is usually severed from the larynx as the first step after exposure of the parts by section of the integument, and then a leaden or vulcanite tube (Foulis), a rubber tube (Novaro), or a tampon-canula (von Bruns) sufficiently capacious to make an air-tight fit, is introduced into the trachea.

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[1] Loc. cit.

The patient having been anæsthetized, measures must be taken to prevent escape of blood into the lower air-passages. This may be effected by operating upon the pendent head (Rose's position), or in the same position as modified by Maas, who shoves a footstool under the middle portion of the vertebral column so as to bring the entire field of operation below the level occupied by the canula in the trachea.[1] The same end may be attained by tamponning the trachea, so that the operation may be performed in the usual recumbent position. The air-tampon of Trendelenberg, or some of its modifications, whether with water, air, or sponge, has been used successfully in a number of operations; but, like many other appliances, it is not always continuously reliable. Michael's[2] modification seems to be the most trustworthy device, as far as I can learn from private inquiries. Michael perforates a cylindrical piece of surgical sponge, lets it imbibe moisture, and then runs the canula through it. The sponge is allowed to dry, and is then surrounded by a water-tight membrane, preferably parchment-foil, which is tied on tightly top and bottom, and covered with a solution of gutta percha. When the canula is in position, the sponge is saturated with water or with an antiseptic solution, by means of a puncture made with a hypodermic syringe. By means of a special attachment, the tissues above the canula can be irrigated during the after-treatment, without removing the tube. The ordinary canula may be wound with sponge, as suggested by Nussbaum and employed successfully by Czerny, Billroth, and Gussenbauer, so that in accordance with the belief of the latter, there seems no absolute occasion for any complicated appliance. Lange[3] found tinder to be a much better substance for the purpose than sponge. This seems preferable to the use of either air or water tampons, which are liable to sudden rupture, and may thus unexpectedly complicate the operation. If the larynx be severed from the trachea as the first step of the operation, the trachea is to be tamponed superiorly as far down as the canula, so as to make assurance double-sure. Foulis and Novaro have trusted to air-tight tubes inserted into the top of the severed trachea. Foulis used a curved leaden tube covered with rubber, and Novaro a thick soft-rubber "Nélaton" catheter, secured to the integument with a large pin. Von Bruns used a tampon-canula in the same way. In either instance, subsequent anæsthesia is to be kept up through the tube, the free portion of which presents itself outside of the wound.

In its simplest features, the external relations remaining normal, laryngectomy is practicable as follows: A longitudinal incision is made through the integument in the middle line, reaching from the hyoid bone to the first or second ring of the trachea, care being taken to avoid incision into the tracheal fistula, should a high tracheotomy have been performed. To gain additional room for manipulation, in certain conditions, a second incision is made, crosswise at the level of the hyoid bone, on each side as required, and in such a direction as will make the flaps most available, reaching, if need be, as far back as the sterno-mastoid muscle. The larynx is then exposed in the median line, as described in speaking of complete laryngotomy (p. 719), and the crico-thyroid arteries are ligatured and divided. Any bursæ or glands in the way may be excised. The soft parts overlying the larynx are then to be detached, first from one side, and subsequently from the other. According to Schüller's researches, this is best done by dividing the deep cervical fascia (*fascia profunda colli*, Luschka) immediately enveloping the larynx, so as to afford entrance to an elevator or other blunt instrument, with which the fascia and superjacent tissues may be separated from the thyroid cartilage in mass, and, as far as possible, without the aid of the knife. The thyro-hyoid and sterno-thyroid muscles having been detached from the larynx, and the lateral lobe of the thyroid gland separated with a blunt instrument, without unnecessary rupture of its connections with the trachea—which are useful in restraining descent of the windpipe (Maydl)—the soft parts are to be held to one side with a blunt retractor, and the larynx pulled over to the opposite side with a sharp double hook, so that the constrictor muscles of the pharynx can be divided as close as practicable to their attachments to the thyroid and cricoid cartilages. The thyroid cartilage should then be pulled forwards and to the opposite side, so as to expose the superior laryngeal artery as it penetrates the hyo-thyroid membrane (Schüller). This artery should be secured with two ligatures, between which the knife should be passed in severing the hyo-thyroid membrane and the anterior wall of the pharynx in the next stage of the operation. At this point of the procedure, the important decision must be made as to the disposal of the epiglottis. If it is to remain, the knife is passed through and beyond the hyo-thyroid membrane, and the thyro-epiglottic ligaments are severed. If it is to be removed, the knife is to be carried upwards through the hyo-thyroid membrane instead of backwards, so as to pass between the tongue and the epiglottis, and its course may be controlled (Schüller) by guidance of the left forefinger passed into the patient's mouth. When the lateral portion of the membrane is divided first, the epiglottis can be drawn out, and can thus be protected from the range of the knife in completing the section. The entire larynx is now to be pulled forward by means of sharp hooks inserted at its superior incisure, a blunt tool is to be gently insinuated behind the cricoid cartilage to keep it clear from the posterior pharyngo-œsophageal wall, and the larynx is then to be separated from its further connections with the pharynx and the œsophagus, first laterally, and then from above downwards. Special care is requisite in freeing the cricoid cartilage from the anterior wall of the œsophagus. Any bleeding vessels unattended to during the dissection should now be permanently secured, when, all hemorrhage being under control, the trachea, unless already adherent to the integument, is to be secured by two ligatures, and then the final step of the exsection is taken by severing the larynx from the trachea from behind forwards. Should it be evident, before this final section is made, that the cricoid cartilage is in no way involved in the disease, it is considered highly desirable (Maas, Wegner) to make the section through this part so as to leave a very small strip of the cartilage intact, as an additional support for the adjustment of an artificial substitute for the larynx. Should the cricoid cartilage or its mucous membrane be in any way involved in the disease, the section should be made in the crico-tracheal membrane, or better, perhaps, below the first ring of the trachea. Should the trachea exhibit indications of disease at this point, the section should be made between the second and third rings. The upper end of the divided trachea is finally secured to the integument by several points of interrupted suture.

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[1] Arch. f. klin. Chir., Bd. xix. S. 507. 1876.

[2] Ibid., Bd. xxviii. H. 3.

[3] Archives of Laryngology, p. 41. 1880.

In suturing the trachea to the integument, Gussenbauer recommends a plan employed by himself: From two to four deep sutures are taken beneath a ring, to secure the trachea firmly to the integument, while several superficial stitches are employed to bring the tracheal mucous membrane into accurate contact with the skin, so that their epithelial layers may become united. The better to accomplish this result, Gussenbauer deems it desirable to remove, in part or in whole, any projecting anterior portion of a tracheal cartilage in the domain of the line of union. Exact approximation, he contends, insures union by first intention; while secure union of the trachea to the lower corner of the wound in the neck is of considerable importance in the subsequent course of the case.

Should it be deemed preferable, after separating the soft parts from their connection with the larynx, to remove the latter from below upward, the trachea, if not adherent to the integument, is secured by two ligatures, and is then severed from the larynx above the first ring, after which it is stitched to the integument, and securely tamponned. Care must be taken not to "buttonhole the œsophagus." Gussenbauer recommends severance of the trachea with the thermo-cautery. The trachea having been rendered secure, the larynx is to be pulled forward and upward with a sharp double hook inserted into the cricoid cartilage, and the organ is then to be loosened from its connections from below upwards, the final step of the procedure being its separation from the hyoid bone.

In several instances in which this method of excision has been employed, its steps have been disturbed by failure in the air-tight occlusion of the trachea.

In the more extensive operations necessary for the removal of other structures in addition to the larynx, the details of the operation will vary with the conditions of the integument and of the soft parts, the relations of which will have undergone some change. In operating upon these complicated cases, care to cut no vessel before it has been secured between double ligatures will reduce hemorrhage to a minimum, and care to retain as much healthy tissue as practicable will favor the after-treatment. Every source of visible hemorrhage should be controlled by temporary compression, and by subsequent torsion or ligature if necessary.

Unilateral Laryngectomy.—In performing this operation, as described by Hahn,[1] the operator carries an incision towards the diseased side at about the level of the hyoid bone, and makes a second incision in the median line down to the cricoid cartilage. The soft parts are next separated from the thyroid cartilage, which is then split, after which the larynx is carefully inspected. If one half only is diseased, every affected portion is removed—thyroid cartilage, soft parts, arytenoid cartilage, and a portion of the cricoid cartilage. If unilateral exsection is impossible, the cricoid cartilage is not split. The cricoid cartilage is severed from the trachea and the separation effected from below upwards. The œsophagus and the thyro-hyoid membrane are united by sutures.

A long canula is introduced, surrounded with Michael's tampon, and is retained in position for some twelve hours. At each dressing the trachea is tamponned from above with iodoformed sponge.[2]

After-treatment of Laryngectomy.—The operation being practically over, both larynx and wound should be rigidly scrutinized as to the thoroughness of the removal of diseased tissue. Any suspected remnants should be immediately excised. Whether the edges of the wound or gap in the anterior pharyngo-œsophageal wall should be united by suture, is a question to be answered, as a rule, in the negative. There is considerable diversity of opinion as to the utility of sutures here. They are often in the way of after-treatment, and they often tear out. Hence they seem advisable only as temporary supports when large portions of the gullet have been removed. In one case, Winiwarter, who has been one of the most successful operators, pulled the anterior wall of the œsophagus in front of the trachea, and secured it with sutures to the cutaneous wound, so as to prevent escape of foreign matters into the air-passages. It seems generally conceded that no sutures should be taken in the integument, except to keep the transverse or oblique edges of large flaps in apposition. The central portion of the wound should be left freely exposed to facilitate drainage, and to aid the manipulations necessary in the after-treatment. When bleeding has ceased, the entire raw surface should be sprayed or douched with an antiseptic solution, a five-per-cent. zinc-chloride solution being preferred by most operators. A thick, soft-rubber catheter of large calibre is then passed into the stomach through the wound, and allowed to project externally. This is secured by a ligature, so that it shall remain in position for several days for purposes of nutrition. The wound is then closely packed with antiseptic gauze or cotton. Salicylic acid, carbolic acid, iodine, or iodoform is used, according to the preference of the operator. The dressings are usually withdrawn and replaced every day, a tampon-canula being in use while the wound is being washed or irrigated. Some operators keep a continuous cloud of antiseptic spray playing over the wound for several days, the more thoroughly to keep it disinfected. Nourishment and stimulus are freely supplied at regular intervals by means of a funnel inserted into the stomach-tube, the external orifice of which is kept plugged at other times. The subsequent management of the case has to be conducted on general surgical principles, it being understood that the whole after-treatment requires the assiduous supervision of the surgeon for at least two weeks, that it will severely tax his patience and his ingenuity, and that it may disappoint him in the end. After a few days, when the track of the wound begins to be firm, the stomach-tube is removed, and replaced only at times of feeding, the patient being encouraged from time to time to try and swallow food. When this can be accomplished, the stomach-tube is laid aside definitively. In one of Czerny's cases this was practicable after the fifth day. The tampon-canula is usually employed instead of the ordinary tracheotomy-tube as long as any danger of secondary hemorrhage remains, say for a period of eight or ten days. Attempts to introduce an artificial larynx should be delayed until the parts have somewhat assumed their permanent, cicatricial form, say for a period of about two weeks. Too early attempts at its use sometimes produce hemorrhage, while the shape of an apparatus which is adjustable at first, is often useless after cicatrization of the canal of extirpation.

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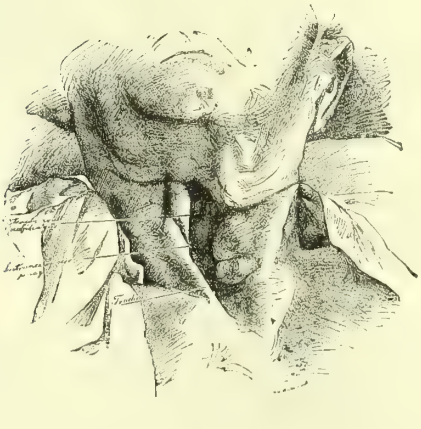
[1] Berliner klin. Woch., 16 Juni, 1884, S. 383.

[2] Hahn, loc. cit.

Fig. 1095.

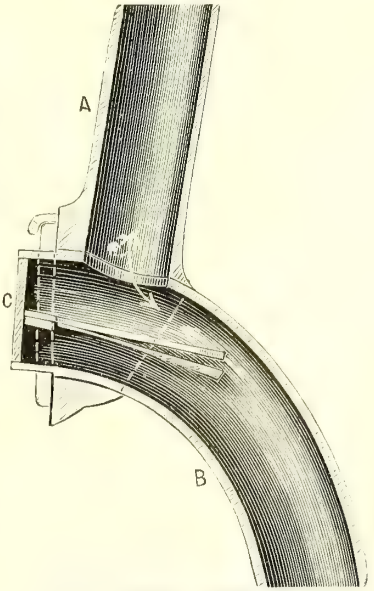


Appearance of parts after laryngectomy. (Lange.)

As a rule, cicatrization is satisfactory, so that the integument closes quite up to the orifice of the canula. When a large portion of the integument has had to be removed for disease, or has sloughed away, quite a large and irregular orifice may remain uncovered, as in the case illustrated by Dr. Lange (Fig. 1095), in the Archives of Laryngology. A defect of this kind interferes materially with the function of deglutition, and necessitates quite a complicated appliance as a substitute for the missing tissues.

Artificial Larynx and Artificial Phonatory Apparatus.—Czerny's original experiments included the adjustment of an artificial appliance to replace the exsected larynx, and to re-establish a respiratory tract by way of the pharynx and the nasal passages; his object being, in addition, to interpose, in the human subject, a phonal reed to serve as a substitute for the voice. This object was kept in view in the very first laryngectomy undertaken on the authority of his experiments, and an appliance constructed on a design by Gussenbauer, was introduced into the pharyngo-tracheal canal of the patient upon whom Billroth had verified the accuracy of Czerny's indications.[1] It consisted essentially of a tube containing a vibratory reed, intended to be placed at will in the air-space of a sort of ⊢ shaped canula, the upper limb of which reached into the pharynx, and the lower limb into the trachea, while the small horizontal limb was directed forward; such a canula, in fact, as had been used by Richet and others, to re-establish respiration by way of the natural passages, after tracheotomy for stricture of the larynx or other obstruction. The entire appliance comprised three tubes: 1, a tracheal canula, with a large fenestrum on its convex surface; 2, a pharyngeal canula with a similar fenestrum, to be passed through the first one in a reversed direction, so that the two apertures should meet and permit an unobstructed current from the bottom of the lower one to the top of the upper one, thus far representing the old appliance alluded to; and 3, a short adjustable tube fitting into the pharyngeal tube, and supplied with a plate carrying a vibratory reed. The apparatus being in position, the expiratory current on its way to the mouth sets the reed into vibration, producing a sound as in the reed of an instrument of music; and the tone thus produced, broken with articulate speech, serves as a substitute for normal voice. The tone is monotonous, modulation being impracticable. The reed-case is made detachable, so that it can be freed from mucus from time to time. The original apparatus was supplied with a substitute for the epiglottis, maintained erect by a watch-spring weak enough to yield readily to the descent of the base of the tongue in deglutition. This has been found unnecessary, however, and rather in the way. Gussenbauer's tube has undergone a number of modifications, three of which are of special value. First, the reversal of the mechanism of the two air-tubes, so that the pharyngeal air-tube is introduced first, and the tracheal tube through it. Second, grooving the interior of the pharyngeal tube so that the plate carrying the reed can be shoved in and withdrawn after the manner of a table-drawer. These suggestions (Fig. 1096) have emanated from Dr. Irvine, of

Fig. 1096.



Irvine's modification of Gussenbauer's artificial phonatory apparatus. (Mackenzie, after Foulis.) *A.* Pharyngeal limb. *B.* Tracheal limb. *C.* The phonatory reed.

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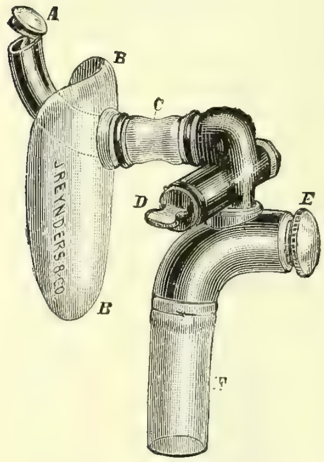
[1] Arch. f. klin. Chir., Bd. xvii. S. 349. 1874.

Glasgow, and were employed in Foulis's case.[1] The third modification alluded to, and which I think is due to Gussenbauer, is a flexible pharyngeal tube, arranged in lobster-tailed links.[2] Similar flexible appliances have been constructed on devices of V. von Bruns and of Caselli. Heine[3] has modified the original device both by flattening the pharyngeal canula and giving it a more rectangular shape, so that it can be directed forward rather than backward and that the conduit can be thus straightened; and by adjusting a turn-key to the reed, so that it can be moved aside when not in use, and thus be less of an obstruction to respiration. Metal, ivory, hard rubber and soft rubber, constitute the chief materials used for reeds. Some observations of my own, years ago, on artificial speech, seemed to indicate that plates of ivory, shaved very thin, would imitate the human voice better than any other material, but I have not the slightest personal knowledge of the working of an artificial larynx in the subject of a laryngectomy.

Fig. 1097.



Artificial larynx with œsophageal obturator. (Lange.) *A.* Epiglottis. *B.* Artificial anterior wall of the œsophagus. *C.* Soft rubber connection. *D.* Chamber containing removable vocal bands. *E.* Rubber cork, removable for opening or closing the tracheal tube. *F.* Tracheal tube with lower portion entering the trachea, made of soft rubber.

It is hardly requisite to go into farther details concerning these appliances. Nearly every case is liable to present some individual features requiring an apparatus specially constructed to meet them. Sometimes very complicated apparatus is required (Fig. 1097), as when an attempt is made to supply the missing anterior wall of the œsophagus, as was done in Lange's case.[4]

Great difference is presented in the toleration of these appliances. In some instances they give little trouble, and are used with great comfort. Some subjects bear the naked apparatus well, but cannot tolerate the phonal reed, which may impede respiration, may become obstructed with desiccated mucus, and may yield a tone to every breath of expiration. Some abandon them altogether, and stick to the simple tracheal canula. In some instances, saliva, mucus, and aliment will get into the tubes and descend into the trachea. Some patients prevent the escape of food by plugging the upper orifice with cotton, when they eat. Czerny closed the top of the tube, in one instance, with a sort of hood, and placed the respiratory orifice in the front wall. This orifice was occluded during deglutition by the broad plate of a soft rubber ring, cut in the shape of a seal-ring and drawn over the top—a cricoid structure at the wrong end of the larynx.

MOTOR DISTURBANCES OF THE INTRINSIC LARYNGEAL MUSCLES.

Motor disturbances of the intrinsic muscles of the larynx often produce subjective symptoms similar to those discussed in connection with diseases of a surgical character, and some of them are to be remedied only by surgical intervention. The cause may reside in disease of the nerve, in disease of the muscle, in disease of the joint, or in cicatricial adhesions. Close scrutiny under laryngoscopic illumination is essential to a correct appreciation of these conditions. Voice and respiration are the processes whose function is most interfered with. Impairments of voice may be dismissed from extended surgical comment, but impairments in respiration demand special elucidation. Voice and respiration require maintenance of the integrity of the chink of the glottis in both directions. When the chink cannot be properly closed, the voice is impaired; when it cannot be properly opened, respiration suffers. Hence it is with palsies of the muscles by which the chink of the glottis is opened that surgery is most closely associated, whether the loss of power be due to spasm of antagonizing muscles, to paralysis of the inactive muscles, to their atrophy, to their infiltration by inflammatory products, or to their restraint by immobility of the articulations whose movements are ordinarily under their control.

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[1] Lancet, January 26, 1878, p. 119.

[2] Prager med. Woch., No. 31, 1883. Separat-Abdruck.

[3] Bohm. Correspondenz-Blatt., No. 17, 1874.

[4] Loc. cit.

Spasm.—Spasm of the dilating muscles of the larynx, an infrequent phenomenon, possesses the merely negative surgical interest comprised in laryngoscopic assurance that the attending aphonia is not due to disease requiring surgical treatment.

Spasm of the constricting muscles of the larynx is a much more frequent and much more serious disorder, for should the spasm fail to relax, death by suffocative apnœa is inevitable. It is of neuropathic origin, occasionally direct, much more frequently reflex. The spasm is far most frequent in the muscles which bring the vocal bands in contact; but it sometimes occurs in those which bring the ventricular bands in contact, and in those which bring the epiglottis down over the glottis. These spasms produce similar symptoms, most pronounced in the first variety; phonal stridor in inspiration, similar to that observed in acute laryngitis, in croup, in whooping-cough, and when a foreign body is in the larynx. Hence the name *laryngismus stridulus* given to the disorder. It is sometimes choreic in character. It is far the more frequent in children, especially in scrofulous and rickety subjects, usually during the period of the first dentition, and chiefly among those weaned too early, and thereby subjected to gastro-intestinal disorders. It is sometimes fatal, occasionally even in the new-born babe.[1] Spasmodic constriction of the ventricular bands is unusual, but examples are seen in sufficient numbers to make it a subject of remark. It is impossible to decide whether it exists unassociated with spasm of the vocal bands. Spasmodic depression of the epiglottis occurs both in adults and in children. In two published instances[2] noted by myself, children have died from incarceration of the epiglottis in the cavity of the larynx, so that the belief may be entertained that laryngismus affecting the vocal bands may be associated, at times, with spasm of the muscles (aryteno-epiglottic) which depress the epiglottis. Having witnessed the same spasm of the aryteno-epiglottic muscles in adults, and having been able to insure the patients comparative safety from its unpleasant consequences by teaching them, with their own fingers, how to release the impacted epiglottis, the inference has followed that sudden suffocation at table is sometimes due to impaction of the epiglottis, an opinion which was long before expressed, however, by M. de la Harpe.[3]

Although usually due in children to reflex irritation of the trifacial nerve in dentition, of the pneumogastric in nutrition, or of the sympathetic and spinal nerves in gastro-intestinal disturbances, yet direct irritation of the pneumogastric or spinal accessory by pressure of enlarged bronchial glands, direct irritation of the meninges by caries of the uppermost cervical vertebra, or of the base of the skull, and direct pressure on the trachea or nerves by abscess, enlarged thymus, or bronchial glands, have been found after death to have been the cause of spasm of the glottis. Aural disease and nasal disease are occasional causes of spasm of the glottis both in the child and in the adult. In some subjects of locomotor ataxia, and in some subjects with epilepsy, spasms of the larynx, by some termed *laryngeal crises* and *laryngeal vertigo*, occur as part of the natural history of the disease.

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[1] Miller, Brit. Med. Jour., Nov. 17, 1877, p. 698.

[2] Op. cit., p. 626.

[3] Schweiz. Zeitschrift für Medizin, u. s. w., Nr. 3, 1849; cited by Fischer (op. cit., S. 103).

Symptoms.—These comprise short series of paroxysms of inspiratory stridor, lasting a few seconds at a time, and recurring at intervals of very variable duration—sometimes associated with cough, sometimes producing unconsciousness, and sometimes followed by eclampsia.

Diagnosis.—The absence of fever, of cough, and of impairment of voice, distinguishes spasm from croup, for which it is most likely to be mistaken. Soreness of the gums, a history of improper feeding, or the detection of other sources of irritation, local or constitutional, may be considered as confirmatory of the diagnosis. Occasionally, a laryngoscopic examination in a sensitive subject produces a spasm of the larynx; and under these conditions, its physical features can be recognized in spasmodic approximation of the vocal bands, or of the ventricular bands, or in spasmodic depression of the epiglottis. In the adult, such a spasm may be produced voluntarily for purposes of laryngoscopic inspection of its mechanism. In a first paroxysm, laryngoscopy is impracticable, but preparation being made beforehand, views of subsequent spasms may be caught in time. Laryngoscopic inspection, after relaxation of the spasm, will reveal the absence of local disease for which the affection might be mistaken.

Prognosis.—Liability to suffocative apnœa during any individual spasm renders the prognosis doubtful to that extent; but relaxation almost always takes place, probably from the anæsthetic effect of retained carbonic acid, often just as suffocation seems inevitable. The ultimate prognosis depends on the nature of the exciting cause and on its susceptibility to treatment. In slight cases, the tendency to spasm is usually overcome within a few days, and recurrences may be prevented or mitigated by the institution of appropriate measures, topical and constitutional. The prognosis, as given by some observers, is much more gloomy than is here indicated. Thus,[1] Barthez and Rilliet had 8 deaths among 9 patients, Hérard 6 out of 7, Reid 115 out of 289, Lorent 77 out of 200, and Salathé 2 out of 24. Rühle considers the prognosis unfavorable on the whole. Wunderlich says that about one-third of all attacked, and the majority of those visited with severe attacks, die. Bouchut says that more than one-half, and Steiner is of the opinion that the great majority, die.

Treatment.—Cold affusions, flagellations, the application of ammonia to the nose, holding the nose to force involuntary inspiration (Schæffer), and searching for an impacted epiglottis, are about all that can be done in the presence of an initial or unawaited spasm. For facilitating relaxation of the spasm in subsequent paroxysms, the warm bath may be kept prepared for immediate use, chloroform or amyl nitrite may be kept ready for use in inhalation; and morphine for use hypodermically. Efforts should be instituted to remove the sources of reflex irritation, which may reside in the mouth, larynx, stomach, intestines, anus, vagina, prepuce, spinal column, or brain. Medicinally, assafœtida, chloral, and the bromides may be indicated—or cod-liver oil, iodides, and calcium-chloride—with such general hygienic and dietetic supervision as may best improve the general health.

In cases of repeated threatening spasm in children or in adults, the only line of safety may be in the direction of prophylactic tracheotomy. In the presence of actual suffocative apnœa, prompt incision into the air-passage (meso-chondric laryngotomy) may be the sole means of averting death. In the presence of apparent death by apnœa, the fleeting life may be recalled by immediate incision, and the institution of artificial respiration.

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[1] Steffen, Ziemssen's Cyclopædia, vol. vii., p. 1018. New York, 1876.

PARALYSIS.—Paralysis of the intrinsic muscles of the larynx may be due to two groups of lesions: *first*, to lack of innervation, whether from disease or injury at the nerve centre, disease or injury of nerve filaments, or compression at the nerve centre or along some portion of the nerve tract; *second*, to disease or injury of the muscular fibres, or to infiltrations between them. Apparent paralysis may be due to mechanical restraint—most frequently an anchylosis at the crico-arytenoid articulation, whether true or false. Paralysis may be functional or organic. *Functional paralysis* needs little comment here. It occurs chiefly in hyperæsthetic and hysterical subjects, is almost exclusively bilateral, and is usually readily amenable to measures medicinal and psychical. *Organic paralysis* may be unilateral or bilateral, and either form may be partial (paresis) or complete. It may be in the domain of either the superior or inferior laryngeal nerve, or it may involve both. It may be limited to the larynx, or it may be associated with paralysis of the pharynx or palate, or with regional paralysis, or with general paralysis. Thus paralysis in the domain of the recurrent laryngeal nerve may be part and parcel of so-called bulbar paralysis, of disseminated cerebro-spinal sclerosis, of progressive muscular atrophy, of tabes dorsalis, or of intra-cranial lesions due to hemorrhage, effusion, gumma, tubercle, or neoplasm, in the domain of the origin of the eighth pair of nerves, at the floor of the fourth ventricle. Tracing the functional activity of the structures to which the terminal extremities of the cranial nerves are distributed, the location of the lesion may be inferred with considerable accuracy, and its extent determined within limits of great probability. Paralysis in the domain of the superior laryngeal nerve is most frequent after diphtheria. Unilateral paralysis is usually due to local disease or injury, whether cerebral or peripheral. Bilateral paralysis is usually due to cerebral lesion—to central systemic poisoning, whether septic (diphtheria, pyæmia) or toxæmic (plumbism, nicotism, for example), or to bilateral injury. It is the occasional result of unilateral pressure,[1] Dr. Johnson's[2] explanation being that the irritation conveyed by the afferent filaments to the centres, sets up such disturbance there as to impress the efferent filaments of both sides, and thus cause bilateral paralysis.

That section or other injury of the recurrent nerve would entail aphonia, was known to Galen, who reported[3] one case of an infant attacked with cervical adenitis, and who lost part of its voice, having fallen into the hands of an ignorant person who cut one of these nerves; and another, in which the section was made upon both sides, the person remaining permanently mute. Bilateral paralysis with consequent aphonia occasionally follows severe operations in the cervical region, such as extirpation of the thyroid gland. When due rather to severe handling of the nerve than to actual section, the paralysis gradually subsides, and voice is regained.

Laryngeal paralysis, save, perhaps, that following diphtheria, is much more frequent in adults than in children. Stoerk appears to have been the first observer who recognized this condition laryngoscopically. Organic laryngeal paralysis is most frequently found as a complete paralysis of the recurrent nerve, the vocal band remaining immobile in about the same position that it occupies in the dead subject[1] (*cadaveric position*, Ziemssen), that is to say, nearly midway between its extremes of excursion. When both sets of fibres are not involved, the paralysis is much the more frequent in the domain of the filaments which supply the posterior crico-arytenoid muscles (paralysis of abductor muscles), and the vocal band is unable to leave the phonatory position in the middle line. When the paralysis is confined to the domain of the filaments which supply the lateral crico-arytenoids, the arytenoid, and the thyroid-arytenoid—a very rare combination (paralysis of adductor muscles)—the vocal band remains immobile in the position of extreme inspiration.[2]

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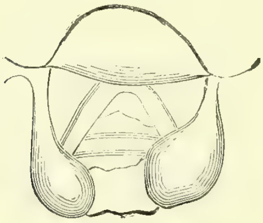
[1] Johnson, Med.-Chir. Trans., vol. lviii. p. 29; Baumler, Arch. f. klin. Med., 22 Feb. 1867.

[2] Transactions International Medical Congress, vol. iii. p. 221. London, 1881.

[3] Mérat, Dict. des Sci. Méd., t. xxxiv. p. 285. Paris, 1818.

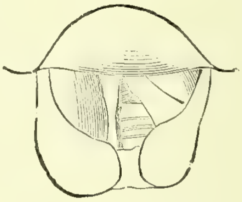
Although paralysis of the dilator muscles (*abductors*, Mackenzie) of the glottis had long been recognized[3] and its clinical aspects appreciated, its general pathological significance had escaped detection until announced by Semon, in a well-conceived and well-written clinical essay,[4] "On the proclivity of the abductor fibres of the recurrent laryngeal nerve to become affected sooner than the adductor fibres, or even exclusively, in cases of undoubted central or peripheral injury or disease of the roots or trunks of the pneumogastric, spinal accessory, or recurrent nerves." In a less well-conceived but equally well-written article,[5] Dr. Semon expresses the opinion that the dilators of the glottis always suffer first in organic diseases of the centre, or of the tract of the motor laryngeal nerves, by reason, as he intimates, of a physiological necessity which precludes the occurrence of initial or exclusive paralysis of the constrictors (*adductors*, Mackenzie) as a result of organic nerve lesion. From this sweeping conclusion I must dissent, or confess an inability to discriminate between the position of the vocal bands in extreme abduction—their position during forced inspiration—and their position in relaxation (*cadaveric position*, Ziemssen). A pair of rude sketches (Figs. 1098 and 1099), reproduced from the first edition of my work on Diseases of the Throat, etc.,[6] in illustration of unilateral paralysis in a case of aneurism of the aorta, the significance of which was unappreciated at the time, are sufficiently characteristic to show that the vocal band is in extreme abduction; but some artistic drawings of the laryngoscopic images (Figs. 1100, 1101, 1102) in a case of paralysis of the left vocal band in extreme abduction, following an incised wound of the neck, and recently reported to the American Laryngological Association,[7] better illustrate the position referred to, although they have been somewhat spoiled in their reproduction on wood.

Fig. 1098.



During respiration.

Fig. 1099.



During attempted phonation.

Mackenzie has met with one case in which paralysis of the adductors was caused by extensive disorganization of the brain from carcinoma;[1] and Cheesman,[2] a case of unilateral paralysis from aneurism of the arch of the aorta, in which the abduction of the vocal band was sufficient to enable him to distinguish the pulsations of the aneurism at the terminus of the trachea. It seems plausible, as suggested by Rossbach,[3] that, in accordance with analogy in muscular functional activity elsewhere, the abductors (dilators) should suffer first in all cases of paralysis of the recurrent nerve, in the same manner that the extensors and abductors are paralyzed first in all other cases of paralysis of nerves or nerve-centres, while the sphincters, which correspond to the adductors (constrictors) of the larynx, are attacked last. This does not necessarily exclude the possibility of exceptions to the rule. But the uncertainty as to the part that the superior laryngeal nerve may take in the innervation of the arytenoideus muscle, and the intricacy of the bilateral innervation of that muscle for duty on the two sides, present so many features for recognition, that the etiology of pure adductor-paralysis, as well as of other forms of laryngeal paralysis, awaits satisfactory elucidation in the very face of the striking laryngoscopic pictures of paralysis under almost continuous observation. It is not known whether the double function of the recurrent laryngeal nerve is due to innervation by a common centre, or whether distinct centres preside over separate sets of filaments; while the influence which the nucleus of the pneumogastric may exercise upon abduction of the vocal bands as an organic feature of the respiratory act, is a problem yet unsolved.

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[1] Tuerck, op. cit., S. 442.

[2] For normal picture of extreme inspiration, see Fig. 1047, p. 684.

[3] Gerhardt, Virchow's Archiv, Bd. xxvii., S. 68, 296. 1863.

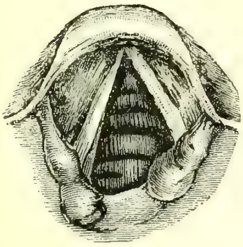
[4] Archives of Laryngology, July, 1881, p. 197.

[5] Berliner klin. Woch., No. 46. 1883.

[6] Op. cit., p. 466. New York, 1872.

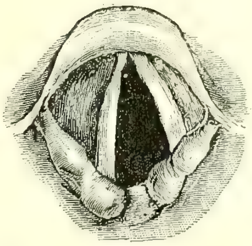
[7] New York Medical Journal, July 26, 1884.

Fig. 1100.



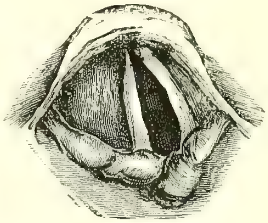
Forced inspiration.

Fig. 1101.



Expiration.

Fig. 1102.



Attempted phonation.

Paralysis of long duration often leads to degeneration of the nerve, and to degeneration and atrophy of the inactive muscles. Inaction of the muscles may lead to anchylosis, as in articulations generally.

Diagnosis.—While paralysis of the intrinsic muscles of the larynx may be inferable from objective symptoms, its due recognition necessitates laryngoscopic inspection.

Paralysis of the posterior crico-arytenoid muscle (*abductor*, Mackenzie) is recognized by fixation of the vocal band in the phonatory position. Unilateral paralysis is, for anatomical reasons, much more frequent on the left side. Bilateral paralysis comes especially under the domain of surgery, for inspiratory dyspnœa is then so urgent that suffocation becomes imminent, and sometimes inevitable, unless prophylactic tracheotomy be performed, especially when any tendency is manifested to spasm of the antagonizing muscles. The vocal bands cannot be abducted to any distance by the most powerful effort; while in marked instances, or during spasm of the antagonists, they cannot be abducted at all. (Fig. 1103.) During inspiration, the vocal bands are drawn so strongly downwards in closer and closer approximation, that sometimes the mucous membrane passes the edges of the fibrous tissue—which then become very prominent beneath it—and vibrates during the stridor. In expiration, the vocal bands are driven upwards in a vaulted manner, and the elliptic or acutely triangular chink of the glottis undergoes enlargement, so that the air passes freely out of the larynx. (Fig. 1104.) Sometimes the picture resembles that of paralysis of the thyro-arytenoids during phonation. In some instances[1] unilateral paralysis precedes the bilateral. Bilateral paralysis sometimes so closely resembles actual adhesion of the opposing faces of the arytenoid cartilages, as to render the diagnosis uncertain from inspection only; while, in its turn, the latter condition may be mistaken for paralysis.[2] There is no loss of voice in either unilateral or bilateral paralysis, although its quality may be impaired; but there is a peculiar mode of utterance in bilateral paralysis, due to interruptions by prolonged stridulent inspirations. There is no dyspnœa in unilateral paralysis except on slight exertion, or from intercurrent disease. There is great dyspnœa in bilateral paralysis—extreme, labored, and stridulent in inspiration; moderate or unnoticed in expiration, unless on exertion—while the inspiratory stridor, especially during sleep, may be so very loud as to be heard in adjoining apartments, or throughout the house.

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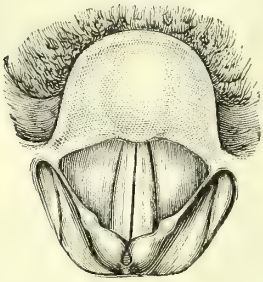
[1] Hoarseness, Loss of Voice, and Stridulous Breathing, pp. 4–6. London, 1868.

[2] Med. Record, Sept. 22, 1882, p. 335.

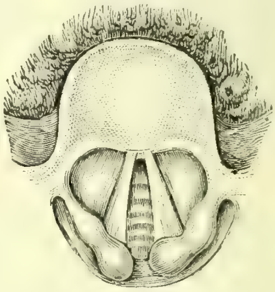
[3] Breslauer aerztliche Zeitschrift., Nos. 2 und 3, 1880; Trans. International Medical Congress, vol. iii. p. 222. London, 1881.

Fig. 1103.



Bilateral paralysis of posterior crico-arytenoid. Inspiration. Patient wearing a canula.

Fig. 1104.



Bilateral paralysis of posterior crico-arytenoid muscle. Expiration. Patient wearing a canula.

Paralysis of the crico-thyroid muscles (*tensors*, Mackenzie) is indicated merely by unevenness in the outline of the edge and upper surface of the vocal band, which is usually congested, and sometimes exhibits pearlish refraction. Should these indications be so slight as to create doubt in diagnosis, reliance is placed mostly upon a lack of precision in phonation—a peculiar, dissonant slide occurring occasionally or frequently during conversation—and upon the fatigue or even pain produced by prolonged vocal effort.

Paralysis of the thyro-arytenoid muscles, the regulators of tension (*relaxors*, Mackenzie; *distenders*, Elsberg)—*Indian-bow paralysis* (German writers)—one of the most frequent forms of laryngeal paralysis, is recognized by approximation of the vocal bands posteriorly, with central enlargement of the chink of the glottis, the orifice being elliptic when the paralysis is bilateral (Fig. 1105), and Indian-bow shaped when unilateral (Fig. 1106). This paralysis is sometimes associated with paralysis of the arytenoid muscle, as indicated by incompleteness of the ellipse posteriorly, and by the appearance of a second ellipse, or rather a hemi-ellipse, behind the unapproximated vocal processes of the arytenoid cartilage (Fig. 1107).

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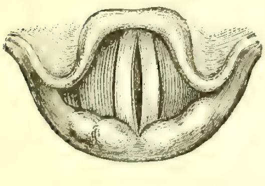
[1] Cohen, op. cit., p. 654.

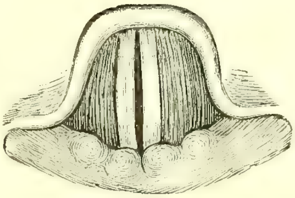
[2] Sidlo, cited by Ziemssen (Cyclopædia of the Practice of Medicine, vol. vii. p. 969). See Luxation of the Larynx, *supra*, p. 662.

Fig. 1105.



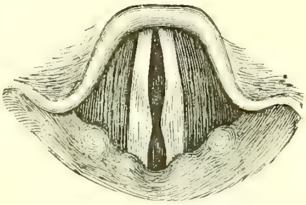
Bilateral paralysis of thyro-arytenoids in acute laryngitis. (Ziemssen.)

Fig. 1106.



Paralysis of right thyro-arytenoid. (Ziemssen.)

Fig. 1107.



Bilateral paralysis of the thyro-arytenoids, with paralysis or paresis of the arytenoid muscle. (Ziemssen.)

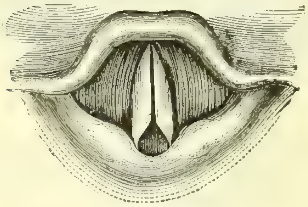
The impairment of phonatory power is manifested chiefly in modulation; but if sufficient effort be made, the voice can usually be held. Its quality is unpleasant under either condition; and vocal effort is fatiguing or even painful. In bilateral paralysis associated with paralysis of the arytenoid muscle, there is dysphonia or aphonia as the case may be.

Paralysis of the lateral crico-arytenoids, usually associated with paralysis of the arytenoid and of the thyro-arytenoid muscles, when of organic origin, is shown by immobility of the vocal band at the extreme limit of its outward excursion. (Figs. 1099, 1101, pp. 782, 783.) On the side involved, the glottis is opened to its widest extent. The paralyzed vocal band fails to advance to the phonatory line in attempted phonation, but the non-paralyzed band will cross the middle line, so that its arytenoid cartilage will stand in front of the other one (Fig. 1102, p. 783), and the lost tension of the thyro-arytenoid may permit the paralyzed vocal band to be bowed upward in the expiratory current. There is aphonia, or at most an exhalatory substitute for voice, hardly phonal in a proper sense. Paralysis of functional origin, sometimes disassociated from paralysis of the arytenoid and thyro-arytenoid muscles, is indicated by its almost unexceptionally bilateral manifestation; the vocal bands remaining very nearly in the respiratory position, with failure of approximation in attempts at phonation, although a weak, incomplete advance, or advance and immediate retreat, is observed in some instances, as though the patient "could not will" to bring the bands together. Approximation of the bands with resultant sound may take place in movements of sneezing, coughing, and laughing. There is no voice, or there is dysphonia with intermittent aphonia. The patient speaks in a laryngeal whisper, with "a phonative waste of breath." (Ziemssen.) In complete paralysis there is absolute aphonia, cough is aphonic and weak, and there is no power to make the explosive "hem."

Paralysis of the arytenoid muscle (*central abductor*, Mackenzie) is recognized by failure in closure of so much of the glottis (*intercartilaginous glottis* of some authors) as lies behind the anterior extremities of the vocal processes of the arytenoid cartilages. The voice is impaired, and is marked by a perceptible expiratory current of unused air, which makes talking fatiguing.

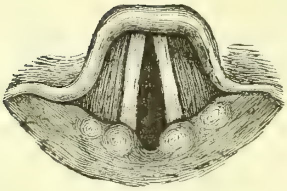
Paralysis of all the filaments in the domain of the recurrent nerve, adductor and abductor—*paralysis of the recurrent*—is recognized by immobility of the vocal band nearly midway between the positions for phonation and for deep inspiration, a little within the ordinary respiratory position (Fig. 1109), the cadaveric position of Ziemssen (Fig. 1110). This position has often been mistaken for that of extreme abduction, and has thus led to unnecessary confusion in the recognition of individual laryngeal palsies. In unilateral paralysis, the unaffected vocal band often crosses the line in phonation, its arytenoid and supra-arytenoid cartilages passing in front of their fellows (Fig. 1109).

Fig. 1108.



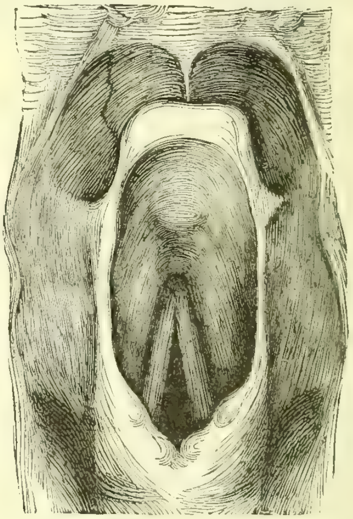
Paralysis of arytenoid; acute laryngitis. (Ziemssen.)

Fig. 1109.



Bilateral paralysis of recurrent nerve. (Ziemssen.)

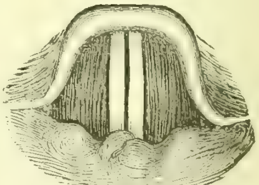
Fig. 1110.



Position of the vocal bands removed from a recent cadaver. (Ziemssen.)

Dysphonia exists in unilateral, and aphonia in bilateral paralysis. The "phonative waste of breath" (Ziemssen) in speaking, is sometimes so marked as to indicate the character of the lesion independently of the laryngoscope. This form of complete paralysis of the recurrent seems (Semon) to be almost invariably preceded by paralysis of the abductor filaments only, the vocal band remaining fixed in the phonatory position, and receding to the cadaveric position only when the adductor filaments become paralyzed. This initiatory phase of the paralysis being usually unilateral, does not affect the voice, and hence escapes recognition; laryngoscopic inspection being rarely instituted until impairment of voice has resulted from complete paralysis in the cadaveric position. Semon suggests that more frequent examination of individuals with nerve-lesions will verify the accuracy of this observation.

Fig. 1111.



Crossing of arytenoid cartilages. (Ziemssen.)

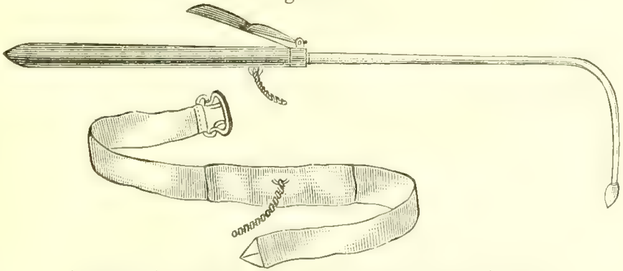
Laryngoscopic inspection reveals the character of the palsies of the larynx, but it does not always detect the lesions which produce them, even when myopathic merely. To complete the diagnosis, it is necessary to interrogate the constitutional integrity of the patient, and to pass in review all possible sources of lesion which, from the nerve-centre to its laryngeal filaments, might be productive of the paralytic condition detected. Paralysis of a vocal band sometimes furnishes the first intimation of the existence of an aneurism of the arch of the aorta; and an autopsy sometimes verifies the accuracy of the diagnosis, even when the ordinary physical signs have eluded detection,[1] as in aneurisms located posteriorly. So too with other affections. Paralysis of the recurrent in laborers accustomed to lift heavy weights, should always suggest the possibility of aneurism. In individuals who do not work hard, it may be one of the precursory manifestations of carcinoma.

Prognosis.—The prognosis depends upon the causal lesion. If this can be cured or removed, the paralysis may be remedied, if nerve and muscle have not suffered irreparable injury. Thus the prognosis is unfavorable in paralysis due to carcinoma of the œsophagus, to intra-thoracic tumor, to aneurism of the aorta, and so on. In paralysis of central origin, the prognosis is presumptively favorable only when that origin is syphilitic. It is much less favorable in systemic poisoning, whether diphtheritic or toxic, although recovery usually ensues in slight cases of diphtheritic paralysis, and often without treatment.

In paralysis of functional origin, and in paralysis due to recent inflammation, the prognosis is exceedingly favorable; yet results do not invariably sustain the prognosis.

Treatment.—Treatment of the underlying lesion is the best method of attacking the paralysis. It often fails, especially when degenerations have taken place in the paralyzed nerve or in the palsied muscles. In bilateral paralysis of the posterior crico-arytenoid muscles, organic in origin, prophylactic tracheotomy should precede other treatment, so that life may be secured from sudden cessation by suffocation. Only in exceptional instances can this important step be justifiably postponed. Rarely can it be ignored. Without it, topical manipulations of any kind are hazardous in the extreme. Strychnine by the mouth, or by hypodermic injection, is the drug of greatest value in most instances of laryngeal paralysis, especially those following diphtheria. Specific treatment is to be instituted in cases which are syphilitic in origin; and antidotal treatment in cases of drug-poisoning. When nerve and muscle have undergone little organic change, direct electrization to the affected muscle, or to the most superficial portion of the nerve-tract which is accessible, will often produce in time a happy response—sometimes an immediate response—especially in cases of functional character, even when of several years' duration. Sudden restoration of voice in this manner sometimes impresses the unsophisticated patient like the mystic paraphernalia of a wizard. The source of the electricity, whether battery-current or induction-coil, seems to

Fig. 1112.



Mackenzie's laryngeal electrode, and electrode for the neck.

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[1] Cohen, Am. Journ. Med. Sci., July, 1883, p. 89.

be a matter of indifference. The electric treatment has been especially simplified by Mackenzie, who has perfected its technical details by adapting the interrupter of the electric cautery to the handle of the laryngeal electrode (Fig. 1112), and by attaching the stationary electrode by a strap to the neck.

Immobility of the Vocal Bands from Mechanical Restraint.—This may be due to inflammatory tumefaction, to inflammatory adhesions, to tumor, to traumatism, to cicatrization, or to false or true anchylosis of the crico-arytenoid articulation.[1] Most of these causes have been discussed. *Anchylosis of the crico-arytenoid articulation* occurs chiefly from perichondritis, and more frequently in syphilis and in the perichondritis following enteric fever; occasionally from arthritic synovitis. In a case under my own care, the anchylosis appeared to be the result of inaction, consequent upon fibroma of the vocal band. The diagnosis is made out by laryngoscopic inspection, and can sometimes be confirmed by palpation with the finger. The pictures seen in the mirror so closely resemble those of paralysis, that discrimination may be difficult unless the history of the case be given due consideration. Asymmetry of the cartilages on the two sides, or tumefaction, may suggest the existence of anchylosis. The symptoms are similar. Surgical treatment by tracheotomy may be required to insure freedom from dangerous dyspnœa.[2]

Apnœa.

Apnœa (α *privative*, and πνέω, I breathe), breathlessness, is used, as a medical term in two senses. Experimental physiologists employ it to indicate the arrest of the respiratory movements observed when the blood is suddenly supplied with an overplus of oxygen—it being well recognized that the respiratory centre in the medulla oblongata is excited by an excess of carbonic acid in the circulating blood, and quieted, or even paralyzed, by excess of oxygen. The terrific muscular efforts observed in the domain of the respiratory motor apparatus, when suffocation is imminent, are quite familiar to practitioners generally; and the momentary suspension of the respiratory act upon sudden abundant access of atmospheric air to the lungs of a cyanosed patient, through an incision just made into the trachea, is quite as familiar to those who have seen much of tracheotomy. This apnœa may lead a surgeon off his guard, to dread, for the moment, that death has ensued at the very instant in which he has secured to his patient a fresh lease of life.

Clinically, the term apnœa is used by many physicians to designate death by suffocation—the word being more accurate, etymologically,[3] than the conventional term asphyxia (α *privative*, and σφύζω, I throb), pulselessness. It is true enough that the death ensues on the cessation of the circulation; and that in many instances of apparent death by apnœa, resuscitation may take place if artificial respiration be instituted before the heart has ceased beating; nevertheless, asphyxia, the final stage of the process, is the result of the apnœa, and not itself the mode of death. Strictly speaking, all death is by apnœa—want of breath—but medically speaking, the term is restricted to death due to sudden stoppage in the aëration of the blood. It may be defined then as cessation of respiration from inability of continuance by reason of insufficiency of oxygen, although there be no immediate cessation of the respiratory act.

Thus apnœa is the mode by which death ensues in all forms of sudden obstruction in the access of atmospheric air to the lungs, and consequent failure in arterialization of the blood. The apnœa may be produced by smothering, throttling, hanging, or drowning; by exposure to mephitic gases, vapors, or fumes; by mechanical occlusion of the air-passage by a foreign body, a neoplasm, or a pathological product; by mechanical compression of the larger air-passages, of the thorax, or of the lungs; by effusion into the air-cells; by collapse of the air-cells; or by spasm of the glottis. In many instances, death, from these causes, is not by apnœa simply, but sometimes by injury to the spinal cord in addition—as in hanging—or by apoplexy from compression of the jugular veins. In some, as when caused by inhalations of chlorine, chloroform, sulphuretted hydrogen, or carbonic oxide, it is more death by a direct poisoning than by mere deprivation of oxygen. Other causes of apnœa are neurotic, such as paralysis of the respiratory centre in disease or injury of the medulla, and paralysis of the nerves or muscles of respiration, including paralysis of the posterior crico-arytenoid muscles, which maintain the patency of the glottis.

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[1] Medical Record, July 1, 1869, p. 218.

[2] For an elaborate discussion of this subject, see Semon (Med. Times and Gaz., vol. ii. 1880); Reprint, London, 1880.

[3] Watson, Lectures on the Principles and Practice of Physic, p. 44. Philadelphia, 1844.

Trained individuals are able, without extraneous aid, to suspend the process of respiration voluntarily for two or three minutes; but in other subjects a suspension of the process for less than two minutes is sufficient to cause death by apnœa. Resuscitation after prolonged suspension is presumptive proof that indistinguishable movements of respiration have been going on to an extent sufficient to prevent absolute arrest of circulation.

Apnœa by drowning, except under unusual circumstances, is rather quicker than apnœa by other causes—the access of water to the lungs driving out air, the retention of which would have prolonged life for a few additional seconds. Total submersion for two minutes is sufficient to extinguish life, as a rule, unless syncope takes place promptly. Syncope diminishes the immediate need for arterialized blood, and thus suppresses the convulsive muscular movements, which favor expulsion of air from the chest, and favor ingress of liquid. In most instances of drowning, the head comes once or oftener to the surface, permitting additional inspirations of air which prolong existence; and most examples of recovery after apparently prolonged submersion are to be explained in this manner.

The mechanism of the arrest of circulation in death by apnœa has long been in dispute, despite numerous autopsies and innumerable experiments upon animals. The views promulgated by Prof. George Johnson, of London,[1] and based in part upon some experiments performed for him by Prof. Rutherford, have recently been reinforced in such strong terms by Dr. Alexander Harvey, of Aberdeen,[2] that it is desirable to present them here in brief. According to this theory, the capillary vessels of the lungs are virtually bloodless at the moment of death, and the lungs themselves are collapsed and anæmic throughout at their base. While the capillaries are virtually empty, minute quantities of blood remain arrested in them at points immediately contiguous to the terminal extremities of the arterioles. This state of things is attributed to mechanical arrest of blood in the pulmonic arterioles, in consequence of an energetic, though not instantaneous, contraction of the muscular arterioles; so that minute portions of blood remain caught at the points designated, although the contents of the capillaries as a whole have become emptied into the venules. It is to the presence of multitudes of these minute collections of blood, still accessible to air which might be conveyed to the air-cells, that resuscitation by artificial respiration is believed to owe its feasibility. The contraction of these muscular arterioles is attributed to the poisonous influence of venous blood which, as such, has already made one complete circuit through the systemic capillaries, after arterialization had ceased. On the contraction of the arterioles, checking, as with compressors, the progress of the blood into the capillaries of the lungs, the pulmonic blood-pressure becomes augmented, and the right side of the heart—the auricle especially—becomes over-distended; while the left auricle, relieved of previous distension by a similar though less forcible action of the systemic arterioles, becomes quite flaccid; the two ventricles being, at the same time, in corresponding relative positions. In connection with this subject, Dr. Johnson quotes from Harvey's Second Disquisition on the Circulation of the Blood, as follows:—[1]

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[1] Lumleian Lectures on the Muscular Arterioles. Reprinted from the Brit. Med. Jour., 1877.

[2] Med. Times and Gaz., Dec. 1 and 8, 1883, pp. 622, 649.

> "I have several times opened the breast and pericardium of a man within two hours after his execution by hanging, and before the color had totally left the face, and in presence of many witnesses, have demonstrated the right auricle of the heart and the lungs distended with blood; the auricle in particular of the size of a large man's fist, and so full of blood that it looked as if it would burst. This distension, however, had disappeared next day, the body having stiffened and become cold, and the blood having made its escape through various channels."

In support of this fact, denied by some recent writers on apnœa, additional evidence is given from a similar autopsy, and from a number of experiments upon animals.

From this account, it would appear that at the moment of death by apnœa, the left side of the heart is not full of blood, while the right side is greatly distended owing to the blocking of the blood in the pulmonic arterioles; and that the circulation is arrested in this condition. The pulmonary artery is full, and can receive no more blood from the distended right ventricle; the right ventricle is full, and can receive no more blood from its auricle; and the auricle remains filled in over-distension.

In some experiments on animals instituted for me by Dr. Solomon Solis-Cohen and Dr. Brubaker, in the physiological laboratory of Jefferson Medical College, it was found, after death by tying the trachea, that the right side of the heart was enormously distended in both chambers, while the left side contained blood, but was not full in either chamber. The pulmonary artery, the venæ cavæ, and the portal vein were also markedly distended, and there appeared to be general engorgement of the venous system. The lungs were not collapsed at death, for the air rushed out of the trachea when the ligature was cut; but on dissection, collapse was evident. At the moment of opening the chest, the lungs were anæmic throughout, and the upper portion of both lungs, and their anterior and lateral peripheries, remained exsanguine; but there very soon appeared diffuse congestion at the base and the dependent portions posteriorly. Animals submitted to death by drowning presented little difference as far as the circulatory system was concerned, except that the left heart was quite full, cardiac action having ceased in diastole; but the lungs were collapsed, and exhibited intense congestion, more marked at the base and in the central portions, the borders being somewhat anæmic. The lungs did not appear to contain water.

Symptoms.—The symptoms of impending apnœa vary within extreme limits, according as it is slow or rapid in disease, or sudden and overwhelming in injury. The symptoms as presented in occlusion of the air-passage by œdema, by a foreign body, by false membrane, by spasm, and by paralysis, have already been described.[2]

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[1] Works, etc., transl. by Willis, p. 127. London, Sydenham Society, 1847.

[2] See pages 651, 670, 704, 705, 779, and 781, *supra*.

Except in slow apnœa, the symptoms are usually sufficiently pronounced to be comprehended by anybody. They consist in general agitation, dyspnœa, forcible efforts at respiration, failure in the process, and coma. Thus in sudden apnœa, with some modifications in severity and sequence, intolerable discomfort—primarily from sensations of a load within the thorax and of compression without—which cannot be gotten rid of or overcome, induces an uncontrollable desire to breathe, and causes the patient to start up or change his position for one in which he either can get air more easily, or can fight for breath more efficiently with the aid of the voluntary muscles of respiration. His countenance expresses both dread and anxiety; he looks from one bystander to another in mute imploration for help; and, often unable to stop to speak, he points to his throat, clutches at his neck, or waves his hands in an outward direction. He declares, perhaps, that his head feels full enough to burst; he complains of vertigo, of tinnitus, and of coruscations. His pulse is rapid; his face is congested; the superficial veins of the head and neck are visibly distended; the eyeballs are prominent; the pupils are dilated and irresponsive to stimuli.

The efforts to secure breath are at first frequent, shallow, and weak, but, being insufficient for the purpose, these are soon succeeded by deeper, more prolonged, and more powerful respirations, the action of all the involuntary muscles being called into play; and as the impotency of these desperate efforts exhausts the strength of the patient, he sinks into a position of indifference and inattention, insensible to things about him, and not responsive to reflex stimulation. Meanwhile the pulse has become slow and feeble, the face livid, the lips blue, the mouth occupied with unexpectorated products of secretion, with accumulations of frothy saliva, mucus, and perhaps blood, at the orifice and at the nostrils; sounds in the larynx indicate accumulations there, perhaps from insensibility of the epiglottis; while eclampsia may take place with forcible constriction of the expiratory muscles, and with such relaxation of the sphincter-groups that there may be involuntary discharges of feces, of urine, and of seminal fluid.

The respiration gradually becomes weaker, shallower, and less frequent; and this is succeeded by spasmodic, snapping gasps for breath, which recur slowly at increasing intervals; the pulse becomes intermittent, and then imperceptible; the face becomes covered with sweat; occasional eclampsia is manifested; coma ensues, and respiration is at an end, although faint contractions of the heart may be detected, in some instances, for from two to four minutes longer, when they cease in turn, and true asphyxia—pulselessness—terminates the life of the individual. The apnœa may be so sudden as to anticipate the usual train of symptoms; and the time occupied in the uninterrupted process rarely exceeds ten minutes under any conditions.

Prognosis.—The prognosis is grave. Recovery is possible only in cases of mechanical obstruction in the air-tract, susceptible of relief before the completion of the process; and even then, often, only after prolonged efforts at resuscitation. Resuscitation may be considered possible as long as the heart continues to beat. Failures in resuscitation are not always attributable to failure in securing access of air to the blood, but are often due to the inability of highly carbonized venous blood to absorb oxygen, its capacity for which, according to the researches of Bernard, will have fallen from 139 : 1000 to 85 : 1000. The blue and blue-black color of the blood is attributed by some observers to excess of carbonic acid, and by others to lack of oxygen. It has been found, too, that the blood-globules lose portions of their hæmatocrystalline, which by microscopic inspection (Preyer) can sometimes be found crystallized in the serum. This disorganization of the blood precludes recovery.

Even successful resuscitation does not always insure permanent recovery; for cases are on record in which death has taken place suddenly, several hours after restoration of normal respiration, and without having left sufficient trace of its cause for detection on post-mortem examination.

Treatment.—The treatment of apnœa must be prompt. Allowance being made for special conditions and circumstances, it may be summed up in efforts to remove the cause, and to arouse the respiratory centres. Apnœa of the new-born, resisting flagellations, is usually treated by mouth to mouth insufflation, by insufflation through a catheter or other tube passed into the larynx through the mouth, or by means of a tube passed through an external incision made in the air-passage. In insufflations of this kind, care is requisite not to use force sufficient to rupture the air-cells. Apnœa by hemorrhage requires transfusion; and the same measure may be required in poisoning by mephitic gases, such as carbonic oxide. In ordinary cases of apnœa from drowning and choking, the mouth and nostrils are to be cleansed from occluding matters, all constricting bands are to be promptly loosened, abundant supply of air is to be secured—if necessary by opening the larynx or trachea—and the patient is to be placed in such a position as will best favor respiration. The cause of the apnœa having been removed, attempts are to be made to rouse the respiratory centre by holding ammonia near the nostrils, and by cold and wet flagellations of the cheeks and chest. Should opportunity be presented, efforts may be made to excite movements of the diaphragm by electrization of the phrenic nerve, one electrode from a powerful induction-coil being placed over the course of the nerve in the neck, and the other electrode being applied at the epigastrium. In absence of prompt response to these measures, resort is to be had to artificial respiration.[2]

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[2] See Vol. I. pp. 514–516.

INJURIES OF THE CHEST.

BY

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CONTUSIONS OF THE CHEST.

THE division commonly adopted in the classification of wounds of the chest, may be employed with advantage in considering the subject of its contusions without wound. In the first group may be placed the contusions which implicate the walls only of the chest; in the second, contusions of the thoracic viscera.

CONTUSIONS LIMITED TO THE THORACIC PARIETES.—The elasticity of the chest-wall, and the free mobility of its integument and of many of the muscles which compose it, render the effect of blows less important here than in many other parts of the body, provided that their force is insufficient to break the bones or the costal cartilages. Such injuries give rise to ecchymoses of moderate extent, and but seldom to circumscribed bloody tumors such as are commonly seen on the head and in the limbs, as the result of bruises of the tissues which cover firmly resisting bones. For the same reason, concussion rarely affects the thoracic viscera in consequence of blows on the chest-wall, if we exclude, as we must do in this article, the injuries of the spinal segment of the wall. Again, sloughing of the skin or of the areolar tissue of the chest-wall rarely occurs after contusions, because of their slight effect on tissues which are backed by an elastic support, and which are freely movable on that support. Abscess of the chest-wall, following contusion, is also a rare phenomenon, except in the form of symptomatic abscess arising indirectly, that is, from a limited caries or necrosis of a rib, or of the sternum; indeed, although injury to these bones is frequently followed by caries or necrosis, still the relation of either, in point of time, to the injury, is so remote that the history of contusion is commonly vague, or entirely lost. The injuries which determine these diseases are usually limited and often trivial bruises, which take an exaggerated effect in subjects of weakly or of strumous habit, circumstances which still further remove these abscesses from association with ordinary contusions.

Pain, the chief symptom attendant on the injuries of this group, is commonly severe, and is aggravated by the movements of respiration, by coughing or sneezing, and by pressure, but it falls short in its characters of the pain which attends a fractured rib. The diagnosis lies between simple contusion and contusion complicated by fracture. In ordinary cases, during the first few days which succeed the injury, the character of the pain alone serves to distinguish the simple from the complicated contusion. In both, the pain is aggravated by motion and by pressure, but the presence of a fracture renders it so acute and sudden that the patient cannot be induced to cough, and shrinks with so sudden and characteristic an expression of suffering when the seat of fracture is pressed, or any movement of the trunk attempted, that the surgeon familiar with these injuries hardly needs to search for the physical signs of fracture. The pain of simple contusion of the chest-wall, and that which accompanies fracture of the ribs, though different in character in these injuries, is in both superficial, a feature which may serve to distinguish it from the deep-seated pain of lacerated or contused lungs. In both contusion of the chest-wall and contusion complicated by fracture, the progress is, as far as this symptom is concerned, similar, provided that no intra-thoracic inflammation or other accident occurs to alter the usual course of such cases toward recovery. The pain gradually loses its acuteness, more rapidly in simple contusion than where fracture is present, and about the tenth day ceases to attract attention. These characters of pain are necessarily ill defined in incomplete fracture of the ribs, a lesion which, in the living, can hardly be distinguished from simple contusion; again, in fractures of the costal cartilages the pain is less marked and less characteristic than that which attends fractures of the bones.

The *attitude* of patients suffering from either of these injuries, as they lie in bed, is, in the earlier days of their progress, most characteristic, and is the direct result of the effort to avoid pain; such patients lie commonly on the back, inclined to the injured side just so far as to set the sound side free without bringing the weight of the body to press on the seat of injury. This attitude is most marked in cases of fracture.

The *treatment* of simple contusion, and of contusion complicated by fracture of the rib or costal cartilage, without injury of the pleura or thoracic viscera, is to be conducted on the same principle—the enforcement of rest, and, if need be, compression of the chest-wall, such as shall limit its motions, either by bandages embracing the entire circumference, or by straps of adhesive plaster drawn tightly over the seat of injury. In simple contusion, complicated only by ecchymosis, pressure may be replaced by lotions compounded with drugs such as are accredited with the power of promoting absorption of effused blood. The guide in selecting the kind of remedy is the expression of the patient's feeling: if pressure be agreeable, it is to be adopted, to be abandoned again if disagreeable; only in contusion complicated by fracture of the costal cartilages, as seen in limited injuries of the chest, does pressure require to be applied with exceptional care and exactness; for very visible and palpable deformity usually attends these fractures, in consequence of the overlapping of the fragments of the broken cartilages—a deformity difficult to overcome, and, if suffered to become permanent, likely to be an opprobrium to surgical skill; beyond this it does not appear to entail any disadvantage.[1]

CONTUSIONS INVOLVING THE THORACIC VISCERA.—The second group, contusions of the viscera without wound of the walls of the chest, contains a series of injuries of the highest importance, both in consequence of the risks to life which they entail, and on account of the difficulties which they present in the way of exact diagnosis.

In the cases of this group which occur most frequently, a direct blow breaks one or two ribs, or more, where it strikes; the force reaching further, drives the fragments of the broken bones inwards, causing, in the least degree, laceration of the parietal layer only of the pleural membrane, with probably slight bruising of the surface of the lung, but falling short of any laceration of the visceral layer of the pleura.

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[1] The detailed examination of fractures of the bones and cartilages of the chest, will be found in the article on fractures.

In severer cases, a force acting with still more continued energy breaks the ribs, and drives the fragments, as in the preceding class, through the external layer of the pleura, and further on into the tissue of the lung: in such injuries a larger area of the chest-wall is crushed, and a greater number of ribs are broken; in post-mortem examination of such cases, not uncommonly the lung is found to carry the impress of the fracture of each broken rib, in a lacerated wound corresponding to the extremities of the depressed fragments all along the line of the injury, the wounds being, however, inflicted on the lung by only one fragment, anterior or posterior, at each seat of fracture, and all by the fragments on the same side of the line. In such injuries, as, for instance, where a cart-wheel passes over the chest and breaks the bones by direct violence, the line of maximum pressure and the direction of its plane may often be inferred, after death, from the arrangement of the wounds of the lung. This may be of importance, as the resiliency of the ribs is such that we do not find their fragments, excepting in very exceptional circumstances, retained in their displaced position as fragments of bone are prone to be in other regions, notably in the skull. In this kind of injury, as the result of the shape of the chest, the number of ribs broken on one side of the body is commonly less than the entire twelve, because the force is rarely so applied as to involve all, and at the top of the row, the clavicle and scapula shield the ribs.

The signs which indicate the existence of lesions of this class, either the least or most severe, vary materially according as the pleural cavity is normal previous to the occurrence of the accident, or has been obliterated in part or entirely by adhesion; a contingency so frequent that it must be taken into account in forming a correct diagnosis. If the cavity be normal, even the most limited wound of the parietal pleura by a fractured rib, gives rise in a short time to a localized traumatic pleuritis, which, although of little risk to the patient if he be otherwise healthy, adds much to his sufferings while it is active, and, under unfavorable conditions, may cause grave trouble.

If adhesions be present at the seat of rupture, this risk is avoided. In the graver injuries, where the ends of the fragments penetrate the lung, the escape of air and of blood into the pleural cavity is facilitated by the normal condition of the cavity, and the risks of pneumo-thorax and of hæmo-thorax are added, while their occurrence points to the diagnosis of the injury. On the other hand, emphysema of the areolar tissue (the result of the escape of air from the lung into its meshes), originating at the seat of contusion, is facilitated by the existence of adhesions; its occurrence in this position without a previous pneumo-thorax is rendered possible; and lastly, as the most trivial laceration may give rise to it when adhesions exist, its gravity as a symptom of wounded lung is greatly diminished.

In considering the value of emphysema of the areolar tissue as a diagnostic sign in these injuries, which are without wound of the integuments, it must be borne in mind that attention must be paid to the place of origin of the emphysema, whether it arise at the seat of injury, the air passing into the areolar tissue external to the parietal pleura which has been torn by fractured bones or cartilages, or, on the other hand, whether it escape through the mediastinum, as indicated by its appearing first in the neck or in the epigastric region. In this mode of origin, the air may leave the pulmonary vesicles or bronchi by rupture of the parenchyma of the lung, entirely independent of any lesion of either layer of the pleural membrane. Commonly this occurrence of general emphysema—even when it reaches to the degree of distending all the subcutaneous tissue of the body—although in appearance, and to the patient's sensation, an alarming symptom, is not attended with serious danger, particularly if it be not associated with pneumo-thorax and if it originate at the seat of fracture of the ribs. If associated with pneumo-thorax, as already mentioned, its presence may increase the embarrassment of respiration caused by the pressure exercised on the lung by the air distending the pleural cavity, but in the gravest fractures of the chest-wall, in fractures of many ribs and of the sternum combined, although emphysema may be present, it does not reach the extent which it attains in injuries of lesser importance, for in the extensive fractures the respiratory power is commonly so impaired that the injection of air into the areolar tissue is made with but feeble effort. The shock, too, attending these accidents adds an important factor to the depression of the power of respiration. For these reasons an excessive emphysema of the body is often endured with less risk to life than more moderate effusion.

The development of general emphysema, particularly when the escape of air takes place at the seat of the contusion, presents the greatest difficulty in the way of an accurate diagnosis by physical examination, for rarely is the examination made before enough air has escaped to mask all other auscultatory signs by its crepitus under pressure, while the percussion note is so modified that even to recognize with certainty the tympany of a pneumothorax is most difficult.

The prognosis in these injuries—contusions of the chest complicated by fractured ribs—when seen by the surgeon within a few hours of their occurrence, depends on a correct estimate of the degree of shock which attends them, of the amount of impairment in respiratory power, and of the number of bones broken. Attention to these points is certainly more necessary than a detailed inquiry into the question of whether the rib-fractures have been caused by direct or indirect violence—a question to which over-much importance is attached by many writers, who, in the study of fractures of the ribs, are led away too readily by the erroneous theory of Petit, that in fracture from indirect violence, the displacement of the fragments being outwards, the thoracic contents are less liable to injury than in fracture from direct violence, with its result, inward displacement.[1] Where many ribs are broken on one or both sides, with or without fracture or dislocation of the sternum or cartilages of the ribs, death takes place almost immediately if there be rupture of the larger vessels. Escaping this rapid death, though small hemorrhages take place at many points, commonly the amount of blood lost is insufficient to cause death; in such cases the patient dies in a few hours, it may be with moderate emphysema of the areolar tissue, lingering with a death-like pallor and feeble breathing, with a falling temperature and cold breath, too depressed to feel, or, at all events, to complain of, much pain. On the other hand, when patients who have suffered serious chest-injury are able to give loud expression of suffering, we commonly find the associated symptoms less grave, the shock moderate, and but little evidence of blood-effusion, even though there be distinct evidence of wound of the lung. In such, the risks are those consequent on reaction, inflammation of the pleura and pericardium, and of the lung. Though undoubtedly a rare termination, even gangrene of the lung may follow such an injury.[2]

Injuries of this class, when seated in the lower parts of the chest, are most liable to be complicated by abdominal lesions, particularly rupture of the liver and of the kidney. Of these the former is the more grave, and, unfortunately, that least capable of recognition, until revealed by post-mortem examination. The complication of lacerated kidney, indicated by hæmaturia, though sometimes serious, is yet often attended with but little risk. Occasionally it becomes a remote source of danger by giving rise to perinephritic abscess, a disease which, should it follow, may delay its development for many months, being at first obscure and ill defined in its characters, and perhaps only revealing its existence by a sudden and unexpected rupture into the peritoneum.

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[1] Bennett, Fractures of the Ribs, an Examination of the Theory of Petit. Dublin Journal of Medical Science, Nov. 1878.

[2] Defontaine, Bulletin Médical du Nord, t. xix. p. 248.

Rupture of Viscera without Fracture.—The injuries of the thorax which possess the highest interest in view of the difficulties attaching to the explanation of their details, are the contusions of the viscera with laceration of their structure, which take place without fracture of the bony cage of the thorax. In many of the examples of these lesions, the subjects have been children, even mere infants, in whose bodies the flexibility and elasticity of the chest-wall is such that it is easier to comprehend the occurrence of laceration of the lung without fracture of the bones, than in the adult. Such are the earliest recorded cases, those of Ambrose Paré and Morgagni. There are, however, abundant examples which establish, on incontrovertible evidence, the fact that such lacerations are not the exclusive property of infancy, or even of early youth. [The Editor has tabulated[1] 30 cases of this kind, with 19 deaths and 11 recoveries.]

Writers on military surgery all admit the frequency of such injuries in the field, involving the lungs, heart, and great vessels, without wound or fracture. No less than twenty-five cases are reported in the Medical and Surgical History of the War of the Rebellion, which are referable to this group; in these we find the age of the patients recorded in seven cases, giving twenty-six years as the average. To many of these cases the term concussion is applied—a term which some writers have applied to all the injuries of this group, and which would appear to have been often used with the idea of establishing an analogy between the injuries of the chest and those of the head. I have already noticed, in excluding them from the scope of this article, the injuries of the spinal segment of the thoracic wall as alone liable to produce damage by concussion. As far as my experience goes, the heart is the only thoracic viscus which appears to suffer from concussion in any manner analogous to the brain. I am well aware that there is good reason to conclude that in most examples of concussion of the brain and spinal cord, structural lesions exist, and that so the term concussion most often implies an injury which escapes discovery through our ignorance in the art of reading symptoms aright, and sometimes the form of injury which is most temporary and reparable. Still, cases are recorded which force us to admit the possibility of concussion which will arrest for a time, or forever, the function of the nervous system, without appreciable lesion of the tissue of the organs. Similarly, among the recorded concussions of the thorax, we have at least one undisputed account of fatal injury, recorded by most competent authority, which presented no anatomical lesion. Nélaton,[2] who records this fact, observed by himself, attaches to it its proper value: "We confine ourselves to the simple statement of the fact, which is entirely exceptional and perhaps unique." The record is as follows:—

> A porter was dragging a small, heavy-laden truck, when the strap broke; his body was consequently thrown violently on the ground, the front of the chest bearing all the force of the shock. In a few moments he was dead, and the autopsy revealed nothing beyond a superficial contusion of the anterior wall of the chest, without any alteration of the thoracic organs.

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[1] Principles and Practice of Surgery, 3d edit., page 365. Philadelphia, 1882.

[2] Pathologie Externe, t. iii. p. 493.

I have seen an injury in which a state approaching fatal syncope followed on a fall from a car, the subject lighting directly on the precordial region, which revealed, on reaction being established, no physical sign, nor any symptom of pulmonary or cardiac lesion, either on the day of the injury or subsequently. Yet the collapse and failure of the circulation was, for a time, so profound and progressive, and of such duration, that it was feared that an intra-thoracic hemorrhage was taking place, and would necessarily prove fatal. Such cases may be regarded as examples of concussion, disturbing the functions of the cardiac ganglia and plexus of the sympathetic, and as such corresponding to the cases of fatal concussion of the semilunar ganglia and solar plexus of the abdomen. Admitting, then, the possibility of concussion of the thorax as a grave or even fatal injury, I desire to avoid the error of describing, as cases of concussion, injuries which either a more complete physical examination during life, or post-mortem inspection, would prove to be contusions of the pleura, or lung, or heart, accompanied with lacerations of the structure of those organs. To return to the subject of contusion of the lungs and pleura without fracture of the ribs,[1] a contusion of the chest which has neither marked the skin nor broken the bones, and which has failed to yield any sign of injury of the lung, may develop a rapid pleuritis, terminating in effusion. The following is a case in point:—

A sailor, aged twenty-four, was admitted into Sir P. Dun's Hospital on December 9, 1867; he was a young man of strong build, and his health had been uninterruptedly good until two days before his admission, when he sustained a severe fall on his back, on board ship. He fell from some considerable height in the rigging on to the deck. Not many hours after the receipt of the injury, he experienced a severe pain and soreness of the right side; he had rigors, followed by some amount of pyrexia. On admission, the symptoms were by no means urgent; there was slight cough, with soreness and sense of general uneasiness, but no dyspnœa. The soreness and inability to move were such as to lead to the diagnosis of an ordinary contusion, without intra-thoracic lesion or fracture of the ribs. Presently the phenomena of a rapidly developing pleural effusion were observed, which increased, in spite of treatment, until, by the ninth day, it filled the entire left side. On this day the left side was dull over its entire extent, both anteriorly and posteriorly, but the dulness did not transgress the median line. The hollows of the intercostal spaces were obliterated, and the respiratory murmur was absent from base to apex. There was no vocal fremitus, and the side was perfectly motionless. The heart was displaced towards the right side, its impulse being perceptible, and its sounds audible, in the middle line. There was puerile respiration on the right side. Pulse, 104; temperature, 103.6° F.; respiration only 24. 10th day. Pulse, 106; respiration, 28; temperature, 101.5° F. Complete dextro-cardia; impulse of the heart, one inch to the right of the sternum. Right side, circumference 17¼ inches; left, 18. On the 11th and 12th days all these symptoms were more advanced, while bronchial rales were audible over the right lung, with increasing dyspnœa. The left pleural cavity was punctured, and forty ounces of clear, straw-colored serum were withdrawn. The relief was immediate; next day the pulse had fallen to 72, and the breathing to 24. An uninterrupted and rapid recovery followed.

In this case there was no ascertainable lesion in either the chest-wall or lung, and, as the character of the fluid drawn by the trocar would seem to prove, not even a trace of blood-effusion in the pleural cavity. Yet some damage to the pleura must have existed, and a large area of the membrane have been involved, else the sudden and rapid effusion could scarcely have arisen in a young and healthy man, whose good physical condition appeared established by the extreme rapidity of his recovery on the abstraction of the effused fluid.

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[1] A long list of authorities may be quoted on this subject, dating back to Paré's case (1582):—Morgagni, Rouppe, Portal, Boyer, Hewson, Laënnec, Hérvez, Roques, Jobert, Dupuytren, R. W. Smith, Saussier, Gosselin, Otis, Coindet, Courtois, and others.

In the next degree of injury, contusion of the lung occurs with effusion of blood into the parenchyma of the lung, and possibly into the air-cells near the pleural surface; but when these conditions exist alone, they in most cases escape diagnosis during life. In the dead body, when other causes have proved fatal, it is not uncommon to find limited blood-extravasations in the tissue of the lung beneath an unbroken pleura, the result of direct or indirect injury.

In graver injuries, blood may be effused in quantity sufficiently large beneath the unbroken pleura, into a lacerated pulmonary parenchyma, to give an appearance, when seen shortly after the injury, somewhat similar to pulmonary apoplexy, or, should the patient live, to yield many of the signs of circumscribed pneumonia, combined with those of a vomica. Indeed, in practice, the phenomenon that indicates such a lesion is the occurrence of sputa not unlike those of pneumonia, appearing a few days after a chest-injury has been inflicted, without the constitutional disturbance of that disease, in a case in fact otherwise progressing favorably. Such a complication attracts attention, and a careful and minute examination detects an area of dulness, of crepitation, and it may be of metallic sounds, such as a cavity yields. Here the disintegration of a blood-clot yields the color to the sputa, and but for its appearance the complication might go unobserved, and the patient be none the worse for the neglect. In these injuries, and even in extensive pulmonary ruptures produced by contusion or by fractured ribs, the coughing up of blood immediately, as in penetrating wounds, is comparatively rare, probably because the injuries are usually inflicted on the external surface of the lung, and remote from the larger bronchi.

In this variety of injury, the pleura being unbroken, there may yet be emphysema of areolar tissue, originating either in the root of the neck or in the epigastric region, the air passing through the root of the lung into the mediastinum, and so reaching upwards or downwards. In injuries of a more advanced type, where the lung and its envelope are freely torn, the rationale of the process, when the ribs or sternum are unbroken, is not quite easily given. Writers, dating from Smith and Gosselin, have offered two explanations: to the earlier we have already referred—namely, the analogy supposed to exist between the lacerations of the brain without fracture of the skull, which are so often seen in so-called cases of concussion, and the lacerations of thoracic viscera. Gosselin, who is followed by more modern writers—Courtois, Follin, and others—rejects this theory, and seemingly on good grounds, viz., the total want of correspondence between the structures of the containing walls of the cavities and of their contents. Rejecting this theory, Gosselin holds that the ruptures of the lungs are, in these cases, direct or indirect, at the seat of the blow or remote from it; and that the condition necessary for either to occur is the closure of the glottis during the period of concussion; in this state the air, being inclosed in the thorax, when suddenly compressed bursts the lung and its envelope, as one may burst an inflated paper bag between the hands. A difficulty arises in accepting this theory, when we consider that the supporters of it range contusions of the lung without fracture in a progressive series, admitting the direct action of the contusion as a force competent to produce the lesser injuries, while to explain the greater lesions of the same group, the occluded glottis is introduced as a new element in the combination of conditions. The experiment of Courtois—the removal of the lungs and trachea from the body, and striking them while the trachea is closed or open—adds but little weight to the theory, for under such circumstances the anatomical surroundings are all changed, and the laws which govern the paper bag, inflated or open, are alone those which apply. A greater difficulty arises when we study the corresponding lesions of the heart and pericardium. Here the explanation of the paper bag, however suitable it may be to the lung—and we do not seek to undervalue its importance—fails, for the gravest laceration of these organs may occur without the chest-wall being broken; even the heart may thus be torn away from all its connections.

The heart and pericardium contain no air, free to escape, or confined, which can be called in to explain, or help in explaining, the rupture of their tissues. The extreme degree of the rupture, observed in some accurately recorded cases of these lung-injuries, appears also to militate against the theory of rupture by air-compression. Again, adopting the theory of Gosselin, if the compression of the air in the lungs were the cause of the rupture, we should expect, if the closed glottis were the cause, that the opposite lung, or both, would be at some time or other found ruptured, but such an occurrence has not yet been recorded—always the rupture is placed somewhere in the lung of the side which has evidently been directly crushed. Smith, too, records the observation of an injury in the body of a dog, run over by a car, in which he says that the pericardium was extensively torn, as well as the lung ruptured; certainly the air could not have ruptured the pericardium. For these reasons, I confess that, much as I value the researches of Gosselin, I cannot accept his theory as complete any more than I do the concussion-theory of Smith. Difficult as it is to accept, I incline to the view that direct pressure, or traction, is the cause of these ruptures. Only such an explanation will apply to the corresponding lesions of the pericardium and heart, and we are forced to admit that the chest, even of the adult, can yield, though without fracture, under sudden strain and impulse, to allow of the infliction of such lacerations as have been recorded.

The symptoms of these injuries are more evident than those of the lesser degrees of contusion; briefly stated, they consist in the sudden development of pneumo-thorax, with the evidence of hemorrhage to a greater or less amount into the pleural cavity, and in some cases hæmoptysis, though this is noted by many as either absent or late in development. Although commonly fatal, we find records of some recoveries; death, in most cases, has taken place rapidly as the result of the bleeding into the pleura, and the compression of the lung by air and blood combined; with these, emphysema has often added to the embarrassment of breathing, and has hastened the fatal termination. While the physical signs and symptoms are mostly well marked, and developed immediately after the injury, there is at least one well-recorded example of their development being delayed for a long period, up to the fifth day:—

A young man, aged 24, admitted to hospital on February 15, 1864, had been knocked down by a heavy-laden cart, the wheel of which passed across his chest. Two hours after, on admission to hospital, his state was not such as to warrant the supposition that there was extensive rupture of any internal organ. The pulse, although rapid, was easily counted, the surface warm, countenance anxious, respiration short; he chiefly complained of his "belly" as the seat of injury, and the region of the liver appeared to be the most tender part. There was no evidence of fractured rib, and no hæmoptysis; he passed water freely, and it was of natural color; his spine was uninjured; on our proceeding to examine his chest, he smiled at the idea, as though he felt there was nothing wrong there, and putting his hand on the epigastrium, said, "oh, my belly! it is my belly!" Respiration was audible in both lungs at this time. On the following day his pulse was ninety, and full; he had quite rallied from the condition of collapse; he still complained of much pain over the liver and epigastrium. On the 18th (3d day) he became slightly, but decidedly, jaundiced; general condition as before; pulse ninety; urine deeply colored with bile, but containing neither sugar nor albumen. On the 20th he became suddenly worse; his breathing rapid and labored; pulse, 120–130, intermitting; countenance much depressed; sweating profusely; dreadful pain in the epigastrium. On examination, the left side of the chest was found to be tympanitic, with respiratory murmur very feeble; the heart displaced to the right side of the sternum; and extensive dulness over the lower portion of the left side of the chest. There had been as yet no hæmoptysis, no trace of external emphysema, no audible metallic tinkling or amphoric resonance; neither did the ecchymosis described by Valentin exist in the lumbar region. On the 21st, in spite of the free administration of opium, his suffering was extreme; it was hardly possible to examine him, so incessant were his cries, "oh, my poor belly! open it and let the wind out."

As there was no doubt as to the fact that blood and air were pent up in the cavity of the left pleura, it was determined, in consultation, to relieve the patient by tapping. Just before proceeding to perform this operation, metallic tinkling and amphoric resonance were heard for the first time, leaving no doubt as to the existence of a wound of the lung. The trocar was introduced two inches external to the nipple; twenty-two and a half ounces of fluid blood (which afterwards coagulated firmly) were drawn off, besides a large quantity of air; the canula was retained in its place, guarded by a valve of membrane to prevent the ingress of air, but permitting the escape of fluid, which dropped away freely all day. The relief to the patient was complete; his pulse ceased to intermit, and he slept soundly. He became, however, gradually weaker, and died (the right lung being attacked by bronchitis) on the tenth day from that on which the injury was received.

At the post-mortem examination the heart was found displaced, and the mediastinum pushed over, while a considerable quantity of gas occupied the left pleural cavity; at least three quarts of blood were contained in the cavity of the left pleura also. The lung was lacerated in a terrible way, a large portion of it being nearly torn off, but no rib was broken. Some of the blood on the upper surface of the diaphragm had coagulated, but the greater part of it was quite fluid. It appeared as if a part of the lung had been adherent when rent off by the shock. The lung was collapsed and lying against the spine.[1]

In this case the rupture was extreme, and the detached portion of the lung was adherent to the chest-wall; here, therefore, there was no necessity to call in an occluded glottis to explain the rent in the lung, the piece being evidently torn off, not burst asunder by compression of the air in the lung. It is hard to explain the delay of the development of the pneumo-thorax and of the hemorrhage into the pleura. The character of the observer precludes any doubt as to the accuracy of the record.

The mechanism of rupture occurring when a portion of the lung is adherent, is the same as that of ruptured pericardium, a tearing of a membrane or tissue under severe and sudden traction.

Ruptures of the heart and pericardium, as the result of contusions of the chest without external wound, occur most commonly as the direct result of fractures of the ribs or sternum, but ample records exist to establish the possibility of almost any kind or degree of rupture independent of fracture of the chest-wall. The most marked example, to which I have already referred, is thus reported by Casper,[2] in proof not only of the possibility of such injury occurring without fracture, but without marking of the surface of the body:—

Complete separation of the heart from its attachments is indubitably one of the rarest discoveries at an autopsy. A dealer in glass, aged 24, in crossing the heights of Spandau on a bitterly cold night in winter, had got off his wagon, heavily laden with boxes of glass, for the purpose of leading his horse down hill; the wagon, however, began to slide, and crushed the unfortunate man, unquestionably with the greatest violence, against one of the poplars which there border the highway; and there he was found, lying dead, that same night, by those who went to seek him immediately on the wagon entering Charlottenburg without a driver. With the most important internal injuries here, there was externally visible nothing save a trifling abrasion of the cuticle over the right cheek bone, and a similar one on the left arm. Who could have suspected what was found internally? On and in the head there was nothing remarkable, only that the sinus transversalis was more than usually full of blood. On opening the spinal canal in the neck, about a quart of dark, fluid blood escaped. The spinous process of the first thoracic vertebra was broken off, and lay loose in the soft parts. The deep muscles of the back were ecchymosed down its whole length; the spinal marrow was uninjured. On opening the left thorax, about thirty ounces of dark fluid were found, but there was no heart in the usual position; on the contrary, it was lying loose on the bottom of the thoracic cavity, for the pericardium had been completely torn across, and the heart torn from the large bloodvessels. The terminations of the aorta and pulmonary artery could be clearly made out; the substance of the heart was tense and firm, and both sides, particularly the ventricles, contained much dark, coagulated blood. The left lung was also torn almost across at its middle division, and, finally, there was a laceration in the right lobe of the liver two inches long and half an inch deep, and yet nothing was perceptible on the body externally.

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[1] McDonnell, Trans. Pathological Society of Dublin, vol. ii., N. S., 1864.

[2] Handbook of the Practice of Forensic Medicine, New Sydenham Society's Translation, vol. i. page 112. London, 1861.

This is perhaps the most extreme case of rupture of the pericardium and of the heart on record, and no fracture of the chest-wall existed, beyond a detachment of the spinous process of a dorsal vertebra, caused by the resistance of the structure against which the body was pressed. We have already referred to its importance as bearing on Gosselin's theory of rupture of the lung. The commonest cause of rupture of the pericardium and heart, as one would *a priori* conclude, is contusion of the chest with fracture of the bones, but a large number of the cases collected by Fischer[1] are examples of rupture without fracture of the bone, 32 to 44 being the proportion. While rupture of the heart and pericardium occur commonly together, in either of these injuries, the heart alone may be the seat of lesion, or the pericardium; among the seventy-six cases referred to, the separate lesions were observed each in five instances. " In all the cases of rupture of the pericardium without lesion of the heart, the rent has been of large size, and has been accompanied by fractures of the ribs and sternum." Such is the assertion of Follin, based on the reports of Fischer and others. I have myself observed an exception to the latter portion of his statement:—

A man, aged 22, a painter, fell on his left shoulder and head, from a height of thirty feet; he died in less than two hours, from the head-injury. There existed a blood-extravasation upon the sternum, and in the middle line of the neck at its lower part. The right lung, otherwise healthy, was deeply bruised, and the pericardium on the right side, where the pleura covers it in front of the root of the lung, was torn vertically, the rent being large enough to admit the hand, which passed into the pericardial cavity behind the phrenic nerve. The heart had a considerable superficial bruise at its base, but no rupture.[2]

A similar case, though from a different cause—the blow of the wadding of a small cannon—where in a healthy young man the heart completely burst the pericardium, without injury to the chest-wall, is recorded by Bonetus.[3]

The facts establishing the possibility of recovery after these injuries, are too few and far between to admit of any general conclusion being drawn from them. There exist the records of supposed dislocation of the heart, of Stokes, and a few others, where life has been prolonged, but the published observations of such cases are too imperfect to prevent the general conclusion that these injuries are mortal: in fact, if the recorded cases be exceptions to the rule, they are only just sufficient to prove that rule.

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[1] Ueber die Wunden des Herzens und des Herzbeutels. Archiv f. klin. Chir. 1868.

[2] Bennett, Dublin Journal of Medical Science, vol. lxviii. 1879.

[3] Sepulchret. lib. iv. sect. 3, obs. 27.

Ruptures of the diaphragm occur as the result of contusions alike of the chest and abdomen, and give rise to the grave complication of hernial protrusion of the abdominal contents into the thorax. Diaphragmatic herniæ are, indeed, more frequently the result of penetrating wounds of the chest, than of contusions without wound, but a sufficient number of the cases on record belong to the latter group to make it a matter of indifference in which connection we study the complication.

The simplest in its mechanism, but by no means the most common of these ruptures, is the laceration of the diaphragm by a fractured rib, as part of a grave injury of the lower part of the thorax. On the occurrence of the rupture, a portion of intestine, or in cases of large rents the stomach and intestines, enter the thorax, and in some cases—those of more limited rupture—immediate strangulation takes place, and so the fatal issue becomes determined; in others—those of larger rent—great embarrassment of breathing with vomiting ensues. The patients in such cases, while they run great risk of speedy death, not infrequently recover, the hernia remaining permanent. In these ruptures of the diaphragm, and in wounds by penetrating weapons or bullets, should the patient survive, the same result has been observed in all instances as far as the lesion of the diaphragm is concerned—the failure of union in its wound, a failure that must sooner or later lead to hernia if this complication does not establish itself at the moment of the injury.

The subject of these injuries of the diaphragm has hitherto fallen more into the hands of medical jurists, than into those of practical surgeons. The best descriptions and collections of cases are those of writers on the medico-legal bearings of the condition—Reid and Devergie—except perhaps the short chapter of Sir A. Cooper. One thing is clear, that in reference to the diagnosis of diaphragmatic hernia, as occurring in practice, our records abound in post-mortem diagnoses. The physical signs and symptoms are indeed easily reduced to description on paper, but the complication, whether or not it has arisen independently of wound or injury, whether it be congenital or traumatic, has commonly escaped detection except by the hands of the pathologist.

As the result of the anatomical disposition of the viscera, the left side of the diaphragm and its crural opening are the most common seats of protrusion, although the right side has been also affected; the mechanical barrier presented by the liver appears to determine this order of frequency; the openings for the epigastric vessels, too, have given rise to idiopathic hernia into the mediastinum.[1]

The question of chiefest interest in these cases, based on what is discovered after death, and capable of being raised in the medico-legal consideration of a contusion or penetrating wound of the thorax, is that studied by Reid,[2] whether, such an hernia being found subsequent to an injury, it can be proved to have resulted from the injury directly, or whether its existence may be attributed to natural causes. On this point anatomy only can give satisfactory evidence: if the hernia be contained in a true hernial sac, its idiopathic origin may be affirmed; an uncertainty exists as to congenital herniæ, for these may or may not possess a sac, many, indeed most, wanting it; traumatic herniæ have no sac. Baudens and subsequently Guthrie advocated operative measures for the relief of strangulation in these herniæ, occurring as a complication of wounds of the thorax, but the success of active treatment remains to be proved: conditions will readily occur to the mind of any practical surgeon, which, being recognized, might be made the subject of treatment, successful at least in averting death by strangulation of the intestine; but the difficulty of rightly appreciating the particular symptoms in the midst of the general disturbance following on either contusions or penetrating wounds of the chest, has hitherto, as has been said, relegated the cases which have not of themselves ended in recovery, to the doubtful benefit of a post-mortem diagnosis. There is ample evidence to prove that, short of the occurrence of intestinal strangulation, these herniæ are capable of prolonged existence without direct risk to life, so that a study of their various histories does not incline me to advocate a hasty abandonment of expectant treatment, even should the surgeon be fortunate enough to arrive at a correct diagnosis. As wounds of the diaphragm fail to unite, and remain permanently open, the extension of the opening by an operation could only add to the risks by causing further increase of the hernia. If the operation is to be undertaken, some means must be devised to obtain closure of the opening in the diaphragm. In the conditions arising from a recent grave wound of the thorax and abdomen, it seems hardly probable that success could follow an operation which would necessarily be, if its details should ever be worked out, most difficult in execution and most prolonged.

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[1] Little, Dublin Journal of Medical Science, vol. lxvi. 1878.

[2] Physiological Researches.

Wounds of the Chest.

Non-penetrating Wounds.—Wounds of the thorax are classified as, first, superficial, involving only the parietes external to the pleural membrane; and, secondly, penetrating. The contrast in the mortality attending these groups respectively, is such that, in studying them, attention becomes instinctively fixed on the graver. The statistics of the last year of the American War of the Rebellion (1864–65), exhibit in the fullest manner this contrast:—

Wounds of the thoracic parietes, 3970.	Deaths,	54.
Penetrating wounds of the chest, 3203.	"	1070.

Again, of the entire number of gunshot flesh wounds recorded during the war, 11,549, one hundred and thirteen died, but in these—

> Death was not always due to the immediate or even remote effects of the injury. Fifteen fatal cases of pyæmia, five of tetanus, eleven of hospital gangrene, eleven of hemorrhage, one of erysipelas, and nine of pulmonary complications—including six cases of pneumonia, two of hydrothorax, and one of empyema—in these fifty-two cases, the injury and death were doubtless directly connected as cause and effect; of fifty cases, in which the fatal issue was referred to diarrhœa and dysentery in nineteen cases, to typhoid fever in twelve, to exhaustion in fifteen, to consumption in two, to anæmia and anasarca in two, it is difficult to determine what relation, if any, existed between the injuries and deaths. Finally, in eleven cases—two of malarial fever, two of cerebritis, one of peritonitis, one of diphtheria, and five of smallpox—it is fair to conclude that the original injuries were less closely connected with the fatal results than were hospitalism and other morbific causes. It appears then, that in uncomplicated, superficial gunshot wounds of the soft coverings of the chest, the mortality is exceedingly small. They commonly cause but little pain, and seldom interfere with the exploration of the lungs by auscultation. They have the disadvantage, however, of healing very slowly, especially when they produce a long groove or canal, or a fistulous track beneath the skin or through the muscles, forming what the French denominate *plaies en sêton*.

Their tedious cicatrization is doubtless due to the want of that absolute rest and immobility requisite for prompt reparation.[1]

When we consider that these remarks are based on the observation of gunshot wounds—not incised, nor even lacerated or punctured wounds—the estimate of gravity falls still lower, for no wound equals in its risks, no matter how trivial it may be, the gunshot. We may therefore take the injuries referred to in the sentences above quoted, as of the worst of their kind; but what a small list of deaths, and how many of them absolutely remote in causation from the wound. In civil practice nothing is seen to change the aspect which the military picture presents; incisions on the thorax do as well as elsewhere, and we rarely see the *plaies en séton* as a result either of accidental or of intentional wound.

The question next in importance, after this short examination of superficial wounds of the chest, leads us on directly to the subject of penetrating wounds. The treatment of the superficial injuries, if we exclude, as is best done at present, the wounds of the axilla and root of the neck, need not delay us, for the ordinary principles of surgery apply, and no exceptional difficulty presents itself in carrying out their details.

PENETRATING WOUNDS OF THE CHEST.—In passing on to penetrating wounds, it does not seem necessary to examine the question of their mechanism, as in the case of contusions, for every one can work out the problem who knows the relations and structure of the viscera, and who understands the essential characters of the kinds of wound inflicted either by cut or stab, or by gunshot injury.

What are the characters that distinguish penetrating from superficial wounds? The kind and direction of the external wound or wounds, difficulty of breathing, hæmoptysis, emphysema, passage of air through the wound, the escape of mingled air and blood from the wound, and, at a later period, pneumonia.

It is evident that, under exceptional conditions, the *kind and direction of the wound* alone may suffice for exact diagnosis: if, for instance, a sword or bayonet has transfixed the chest from before, or laterally, so that the straight line connecting its hilt and point, or the corresponding orifices, must traverse the lung, then no doubt need exist; but such a conclusion may not be drawn from the observation of bullet-injuries, unless indeed the quality and speed of the projectile be accurately known, for the deflection of bullets is a familiar fact. Remove the evidence afforded by an orifice of egress, of either bayonet or bullet, and at once the range of uncertainty increases so that the highest degree of doubt may exist as to the direction and depth of the wound.

Even the existence of two openings is but equivocal evidence that a bullet has passed through and through, for this condition may result from two bullets, neither of which may have entered the cavity.

Difficulty of breathing, Fraser[2] tells us, "is most fallacious as a sign of chest-wound; it may be most intense from moral or other causes, when the lung is not wounded, and it may be altogether absent, when the lung is seriously implicated." In thirty cases of proven wound of the lung, dyspnœa was noted as absent in twenty-two. Not only may there be no dyspnœa at first, but there may be an almost complete immunity from shock.

Hæmoptysis in the same group of cases was wanting in twenty-three, although it has been regarded as most constant by some writers. I have already noted the rarity of its appearance in lacerations of the lung without external wound.

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[1] Med. and Surg. Hist. of the War of the Rebellion, Part First, Surgical Volume, page 472.

[2] Treatise upon Penetrating Wounds of the Chest, page 45. London, 1859.

Again, in these thirty cases, *emphysema* was present but five times, a fact resulting, as Dr. Fraser states, from the injuries having been bullet-wounds, not stabs, for in the latter—in modern warfare, a comparatively rare injury—emphysema is most constant. Its presence in the areolar tissue around a punctured wound does not necessarily imply that the lung is wounded, it may result from the introduction of air into the pleural cavity, the lung escaping any injury, or it may occur in certain superficial injuries without even a wound reaching beyond the superficial muscles. I have seen, for instance, well-marked emphysema around a punctured wound, extending for some distance through the muscular planes where the injury occurred, thus:—

A boy climbing over an iron railing armed with spikes above, slipped in turning over the spikes; he fell, and his clothes and skin catching on the spikes, he was suspended; the spike supporting him entered the posterior fold of the axilla, low down on the chest, and his weight was for a few moments borne by the skin and the latissimus dorsi muscle, with his clothes; he was lifted off by a passer-by, and carried to hospital, when there was found a small wound with emphysema all around and extending beneath the muscle. A couple of days cleared away the indrawn air, and no trace or symptom of wound of the chest-cavity or lung impeded recovery.

Returning to the group of cases above quoted, we find the *passage of air through the wound* present in only seven instances. It would appear, then, that each one of these cardinal symptoms of penetrating wound may be wanting, and, further, that each in its turn is more frequently absent than present; on what then are we to rely for diagnosis?

I would desire to say that, although I would not place implicit reliance on any one of the heretofore accepted signs of lung-wound, if there were three or more of them present, I should consider their concurrence as strong presumptive proofs of lung-wound. To these add a weak pulse, a cold and clammy skin, orthopnœa with effusion of blood—now easily diagnosed by aid of percussion and the stethoscope—and the presence of ecchymosis of blood in the loins (but which I never witnessed, although it is dwelt upon as a certain evidence of effusion into the pleural cavity, by Valentin and others); with all these, or the majority, it may be considered as nearly certain that the substance of the lung has been wounded.[1]

Dr. Fraser's table of cases, of which I have quoted the essential details, supports with the incontrovertible argument of accurately observed facts, his assertions which I have copied. In this may be seen repeated the observation of all exact observers in every branch of medicine, that unqualified reliance cannot be placed on any particular symptom. Nay, even the testimony of two witnesses is insufficient; the whole statute must be fulfilled, and the concurrence of three only can be admitted to be incontrovertible.

The difficulty that seems to be present to the mind of most writers on penetrating wounds, in establishing a correct basis for discussion of the subject, is the theory of collapse of the lung on opening the pleural cavity. It must be borne in mind that the estimate of pulmonary collapse is derived from a very fallacious test, the observation of the phenomenon in the dead body—or rather from an over-estimate of the tendency and amount of the elastic retraction of the lung on the admission of air. The condition of the lung in the living and dead is widely different; in the living, a heated air fills the air-cavities, and the lung-vessels are full of blood exposed to active pressure from the right ventricle of the heart; in the dead, these conditions are reversed, and therefore the lung's power of suddenly retracting on its root must be much less active in the living than in the dead body; and at best, in the dead body, retraction is but moderate, and either a pneumonic swelling or permanent vascular emphysema will suppress it. While I do not for a moment deny that air, or fluid, will readily enter the pleural cavity and accumulate there while the lung retracts under the pressure to its root, I do not see that the elastic traction of the lung towards its root makes the pleural cavity so greedy for air that every wound of the pleura must necessarily lead to pneumo-thorax; even the exertion of respiratory expansion does not appear so certain to cause this influx into the pleural cavity, either in the case of wound of the pulmonary pleura only—as in rupture of the lung without external wound—or in the more evident wound of the costal pleura from without.

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[1] Fraser, op. cit., page 87.

In penetrating wounds which reach only as far as to divide the costal pleura, and more rarely in those that involve the surface of the lung, a *hernia of the lung* may take place as a rare complication, perhaps the rarest of the many attending these injuries. These herniæ are either primary or consecutive. The cases in which primary hernia of the lung has been observed are, first, those of limited and oblique wound, through which air is prevented from entering the pleural cavity by the obliquity, while the egress of the lung under the pressure of muscular effort or the strain of coughing is unopposed; second, cases of wound which permit the entrance of air, but forbid its escape—in these cases the lung escapes only at the moment of infliction of the wound; and third, cases of wound of large size, when the lung escapes at or very soon after the infliction of the injury.[1] It would appear from the records of the American war, that a complication, and possibly a cause, of the hernial protrusion has been, in some cases, the coincidence of a wound of the diaphragm and the escape of abdominal viscera into the pleural cavity, which, by increasing the contents of the thorax, has aided or compelled the protrusion of the lung. The occurrence of a wound of the lung, although it may not render the protrusion of the wounded viscus impossible, clearly opposes its occurrence, for the pressure of the air contained in the lungs and trachea must in a measure fail to act when such an opening exists, and the presence of a pneumo-thorax consequent on the wound tends directly to prevent a hernia by repressing the lung from the chest-wall. The second variety, consecutive hernia, takes place as a remote result of wound of the chest-wall, the tumor arising after the removal of fragments of broken ribs, and during or subsequent to cicatrization of the wound.

There is but a single instance of successful reduction of a traumatic pneumocele without previous ligation, the case of Angelo.[2] A good recovery ensued, though the lung-tissue was wounded. Authors generally advise taxis, and some recommend the enlargement of the wound to return the tumor; but there is no evidence of the expediency of this measure. Excision or ligation were employed in most of the cases, and no bad results appear to have followed these operations. Non-intervention is probably the safer precept. After a while the protrusion contracts adhesions with the walls of the thorax, and occludes the opening.[3]

It would appear by the report quoted, and by the accounts of recorded cases, that there remains a necessity for permanent support by a properly devised pad and bandage to keep the parts secure.

The questions of highest importance in the consideration of penetrating wounds of the chest, are those relating to *hemorrhage*, as a symptom and as the essential object of treatment. In contusions of the chest, too, hemorrhage is, as has been already noted, foremost in importance, but the conditions of those injuries place it more beyond the reach of surgical interference, while its external appearance is comparatively rare. Its total amount is apt to be either extreme, leading to an immediately fatal result, or else comparatively unimportant.

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[1] Morel-Lavallée, Mémoires de la Société de Chirurgie de Paris, t. i.

[2] Gazetta Medica di Milano, Feb. 1844.

[3] Med. and Surg. History of the War of the Rebellion, Part First. Surgical Volume, p. 518.

In penetrating wounds, while the same extremes exist, the intermediate degrees are innumerable. In addition, the symptoms are more evident, and the source, in some cases at least, sufficiently exposed for surgical treatment.

When the *pericardium and heart* or the *great vessels* are the parts involved by a penetrating wound, death is the immediate result in the vast majority of instances. Death may occur in two ways. In the first, a puncture or similar small wound, piercing the pericardium, opens the heart or a great vessel—aorta, pulmonary artery or vein, or vena cava—and the blood, issuing, fills the pericardium, compresses the heart, and kills before the total amount of blood lost is by its quantity sufficient to cause death. A wound in this way may be fatal without opening the heart-cavities or greater vessels, for, striking the coronary artery of the heart only, the fatal result has been brought about in the same way, but in a slightly longer time, a couple of hours; among the records of wounds of this class, inflicted by fine and sharp instruments, we read of lives prolonged for days, for weeks, even for years—but these are among the curiosities of medical literature, not within the category of cases which belong to practical surgery. The knowledge of their having occurred is, however, necessary for the surgeon, in order that he may not commit an error of over-statement in asserting that all wounds of the heart or great vessels must necessarily be fatal. The second mode of death in these injuries is by the sudden and free flow of blood into the pleural cavities or mediastinum; in such cases death takes place at once, or within a few minutes.

Passing from these cases, which are beyond the reach of surgical art, we come to the hemorrhages of more limited and controllable character, where the blood flows from vessels wounded in the parietes of the chest—*intercostal*, *internal mammary*—from the *phrenic*, or from the smaller vessels of the *lung*.

The symptoms which indicate these sources respectively, differ materially, but unfortunately are often so ill defined that an exact diagnosis is impossible; if direct surgical treatment is to avail anything under these circumstances, we cannot be too careful in the attempt to determine the exact source of hemorrhage.

The position of the wound in the chest-wall, intersecting the path of either the intercostal or the internal mammary vessel, and the flow from the wound of a stream of either arterial or venous blood, without hæmoptysis, while percussion reveals an accumulation of fluid in the pleura, form a group of symptoms that are easy to read, and in which the indications are clear; but such are seldom seen. If such were present, no surgeon could fail to seek the bleeding orifice, to dilate the wound if necessary by incision, and, failing to take the vessel by the forceps, tenaculum, or needle, to adopt some one of the many methods specially designed for the control of hemorrhage from these parts. In the exploration for the bleeding point, the position of the intercostal vessel in relation to the rib, placed under cover of its overhanging, inferior border, must be borne in mind. To verify the source from which the jet proceeds, pressure made by a finger in the wound, against the lower border of the rib, may determine the bleeding point or vessel (Boyer); or a gutter-shaped piece of card-board, carried sloping into the wound, may, by catching the blood flowing from above, prove its intercostal source, while a flow from beneath the gutter would point to the thoracic cavity as its origin (Richter). In considering the treatment of a bleeding intercostal or mammary vessel, it must be borne in mind that secondary hemorrhage has more often proved troublesome or fatal in wounds implicating these vessels, than primary bleeding, and that so a greater difficulty has been found in practice, in their case, than would be anticipated from the contemplation of their anatomical relations in the healthy condition. This observation applies to the surgery of all regions, but the difficulties presented by the position of these vessels within the bony cage of the thorax, and by their immediate relation to the cavities of the pleura and pericardium, to which the styptics applicable in corresponding hemorrhages in the limbs are ill suited, require for their treatment a high degree of skill and decision. It so happens that special methods for the management of these cases have been devised in extraordinary number, and perhaps each with merits which may recommend its adoption in some particular emergency. While the wounds which furnish either primary or secondary hemorrhage from these vessels, are at all times, even in warfare, rare, sufficient reason has been shown why, when they occur, the life of the sufferer is often to a great extent placed solely in the hands of the surgeon.

In these circumstances, I cannot help approving the just criticism of the editor of the Surgical History of the American War, on Guthrie and even Boyer, who, each, adopting whatever of these methods suited him or first suggested itself, sneers at all others, at least at all but his own, each thinking his own alone worth notice. It will at once appear to the practical surgeon that the diagnosis of the source of bleeding is more easily made in these cases under the conditions of secondary, than in those of primary hemorrhage, for bleeding from the wounded lung, though possible as a secondary event, is less likely than that attending the separation of sloughs of tissues directly related to broken bone, either sternum or rib. Therefore, although the identification of the source of bleeding has appeared in most cases to have been readily made, the prominent feature of the recorded cases is the difficulty of efficiently controlling the bleeding vessel, in consequence of its altered surroundings, and of the liability of the tissues, softened by disease, to separate too readily under pressure of the ligature or other means adopted. The methods of control are the direct ligature, by tenaculum or forceps, or torsion of the vessel (Guthrie); the including of rib and vessel, and a compress applied over the vessel, with the skin, by a needle carried around all (Girard); the more skilled application with a blunt needle, curved so as to pass around the rib, push aside the pleura, and be capable of introduction from the wound without injury of the skin (Goulard)—the blunt needle of the chain-saw may be used (Howard); complete section of the vessel, as in arteriotomy, with a compress (Assalini); digital pressure maintained by successive hands (Chelius); a compress secured with a thread, passed within the thorax and turned half around, to prevent its escape, and tied against an external support, as in plugging the nose; most generally approved of, yet it would seem but seldom tried, the compress of Desault—a piece of linen pushed within the wound while its edges are maintained without, and the recess so formed filled with padding, so that when the inclosing linen is drawn tight, the contents shall be drawn firmly against the circumference of the wound, pressing thus from within against it; and steel and ivory clips for compression of the rib and vessel, instruments probably efficient though cumbersome, and certainly unlikely to be at hand in the exceptional emergency of these hemorrhages. Finally, the intercostal might be tied at a point on the proximal side of the wound, in order to allow this to remain open and free from compresses. A smaller number of plans have been proposed for securing the *internal mammary* vessel, and various methods of incision have been suggested to expose the artery on the proximal side of the wound. The fatality of hemorrhage from this vessel is very great, as is proven by the statistics collected by Günther (19 cases of wound, 9 ascertained cures, 2 probable cures, and 8 deaths). The rarity of detection of a wound of this vessel, and its fatality, are well shown by the records of the American war:—

> Only five or six cases are found on the records in which wounds of the internal mammary vessel were distinctly recognized. Three of these were treated by compression and styptics, and two by ligation. But there are many other recorded instances of wounds near the edge of the sternum, with hemorrhage, yet without hæmoptysis, in some of which the existence of this lesion may fairly be suspected. As it was fatal in the five cases in which it was detected, it merits serious attention.

The operations on this vessel, practised in the third or upper intercostal spaces, by vertical, oblique, or transverse incisions, with or without the removal of a costal cartilage, have all been formulated, and present no great difficulty in the normal structure of the parts involved, though I can fully conceive that there might be the highest degree of difficulty in the conditions likely to be present in cases of secondary hemorrhage. But in practice these operations have most often failed, for the direct ligature or control of the bleeding point, or the inclusion, rather, of the bleeding orifice between two ligatures, is the only method to be relied on in case of a vessel so freely anastomosing along all its course with arteries of considerable size. It would appear, then, that the attempt should always be made to secure the vessel in the wound—if necessary, by removal of bone or cartilage.

The symptoms which in combination indicate that the lung has been involved in a penetrating wound of the chest are, dyspnœa, hæmoptysis, and a greater or less development of the phenomena of shock; there may, in addition, be evidence of the accumulation of air and of blood in the pleural cavity, and, it may be, the escape of blood and air from the wound with each act of expiration. When all or the greater number of these phenomena are present, there can be no doubt that the lung is wounded; but many, if not all, may be wanting or equivocal in degree, and yet the lung not have escaped, while, on the other hand, many may be present without the lung being involved. Shock and dyspnœa are the common property of both superficial and deep wounds of the chest, and even when present in a marked degree they do not afford reliable evidence of penetration of the lung.

Hæmoptysis, the most essential symptom, may be absent even in deep wounds of the lung, particularly in gunshot wounds and in injuries inflicted by blunt points; and the escape of air and blood externally from the wound, with the motions of breathing, and the evidence afforded by percussion and auscultation of their accumulation in the chest, are phenomena which are common to wounds which merely penetrate the pleural cavity, and to those in which the lung is implicated. In the absence or temporary suppression of these symptoms, the surgeon is strongly tempted to explore the wound by probe or finger, in order to determine its direction, and so complete the diagnosis. But the highest authorities have condemned this practice, and the records of military surgery are not wanting in evidence of the fact that such interference has been at once and evidently fatal. There is, too, ample proof that, in many cases, even when such exploration has been made by both probe and finger, only negative and fallacious conclusions have resulted. Far safer is it for the surgeon to be content to fear the worst and hope for the best, even at the sacrifice of reputation for skill and decision, rather than by a rash exploration to open up a cavity as yet uninvolved, or reprovoke an arrested hemorrhage. "If the surgeon is not too busy with his fingers or probe—too curious to know what will be of little use—the wound in the lung may be united to the external wound, and nothing from the former can fall into the cavity of the pleura."[1]

When a sharp instrument pierces the lung, even superficially, hemorrhage may be profuse; and in cases where any wound traverses the lung near its root, the amount of bleeding may be not only profuse but rapidly fatal. In those grave cases where the source of bleeding is beyond the direct control of the surgeon, where the powers of nature alone must be trusted to restrain the flow, what line of treatment is to be adopted? The coagulation of the blood in the wounded lung, and the compression of the lung by air, or blood, or both, in the pleural cavity, leading to the retraction of the lung, are, with rest, as far as it may be maintained, the only objects to be sought for.

On this subject, more than any other, surgical opinion and practice have changed in recent times. Here venesection lingered longest as the most efficient treatment; venesection, too, carried to the utmost degree, and repeated on every sign of recurrence of bleeding. Up to the time of the Crimean War (1854) this practice prevailed, and was taught in every manual and lecture.

> We induce this fainting by bleeding, and here the bleeding from the arm must be large in quantity and suddenly drawn. The patient's friends may say: "He has already lost a large quantity of blood, and is still losing it; why, therefore, would you take more blood from him?" But do not be debarred from your purpose by anything that may be said or hinted by those who cannot understand your object. There is nothing else to save the patient's life. When you open a vein in one arm, if it does not bleed freely, don't hesitate to open a vein in the other; and you must not be satisfied with a small orifice, for ten ounces of blood taken suddenly will cause fainting, when it would take twenty ounces to produce the same effect if taken slowly. You save blood and the patient's strength in proportion to the freedom with which the blood flows from the vein. But suppose you succeed in lessening or stopping the flow of blood from the mouth, may you relax your vigilance? No, indeed, for in five or six hours it may break out afresh, and you should be on the spot to repeat your venesection instantly. It may return several times in six, ten, or twelve hours, and at each recurrence you must be ready with the lancet; even at every new fit of difficulty of respiration you will bleed, if possible—anything to arrest hemorrhage from the lungs.[2]

Such was the teaching forty years ago by a master of the art, and the prevalent practice, supported by the great military surgeons of his day, was exactly such as he describes. The change to the complete abandonment of the lancet was not long in coming around, and in the American war no longer is there any mention of bleeding to arrest hæmoptysis in penetrating wounds of the chest. The position of this question at the time of the Crimean war is well shown in the following record by Macleod. The case, too, displays fully the wish of the practical surgeon to treat the wound with a free exit for discharge, only restrained by the pressing emergency of the control of hemorrhage:—

> Hannihan, a private in the Royal Irish regiment, was admitted into my wards in the general hospital on the 18th of June. While lying on the ground, with his head towards the enemy, he was struck above the left clavicle by a rifle ball, which traversed his lung from its summit to its base, and was found lying quite superficially in the left lumbar region, from which position it was removed. The dyspnœa, on admission, was very great, and the hæmoptysis was profuse. The surface was cold, and bedewed with cold perspiration. The pulse was weak and tremulous, and the decubitus was on the wounded side. The removal of the ball was followed by a tremendous gush of blood from the incision made, and the blood continued to flow in such quantity that I had to close the wound to prevent immediate dissolution. The necessity of guarding

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[1] Colles's Lectures, vol. i. page 215.

[2] Ibid., page 211.

against a suddenly fatal event was, for the moment, paramount to the indication of freeing the embarrassed lung from the effused blood, and as the hemorrhage, moreover, appeared to be active, I wished to try to check it by the pressure which would result from the blood being allowed to accumulate in the thoracic cavity. The patient was twice largely bled, and he had acetate of lead and opium given him. These measures appeared to afford him some relief. Next day he had rallied considerably. His pulse was better, and his look was less distressed. By the afternoon of that day the dyspnœa became so urgent that I allowed a considerable quantity of the collected blood to escape. This gave him for a time decided relief. The severe exhaustion which, however, soon followed this step, and the return of the dulness to its former level, seemed to intimate a renewal of the hemorrhage, hence I did not reopen the wound, but determined to abstain from all interference till the bleeding vessel had had time to close. The patient was so completely prostrated by the hemorrhage which had evidently taken place internally, that I could not have recourse to any further depletive measures. The stethoscopic examination of the chest discovered amphoric breathing over the upper part of the left lung, while over the whole surface of the right chest the respiration was harsh and loud. Dulness existed on the left side, from the base of the lung up to an inch and a quarter above the level of the nipple. There was suppression of urine for thirty hours after admission. This patient died on the fifth day without any change in his symptoms from those noted above. The left side of the thorax was found more than half full of blood, for the most part fluid. The lung was half solidified and compressed against the spine. Lymph was effused to a limited extent on its surface. The ball had traversed the lung in a direction from above downwards and backwards. Its track was ragged and coated with lymph. The three upper and the three lower ribs were fractured.

Here we have graphically told the cause, symptoms, and treatment of a gunshot injury of exceptional severity, implicating one lung, but just not severe enough to kill outright on the spot, or during the first few hours. An exact parallel in progress, the thoracic being exchanged for abdominal symptoms, might be readily found in the annals of penetrating wounds of the abdomen; a life on the brink of death for a few days, and death on the fifth; a case hopeless throughout, but giving just enough encouragement to the surgeon to induce him to hope even against a certainty. Can one in the face of these phenomena believe that free bleeding at the elbow will mitigate the symptoms of free bleeding into the thorax, or offer much hope for the control of this bleeding? Do not such bleedings as were practised here take away the only hope, as fast as the same loss from a central vessel would? These ideas seem to have forced themselves on the surgical mind at the time of the Crimean War, as we may see clearly in the records of this case, its reporter, as it were, halting between two opinions; as a few years more passed on, we find the treatment absolutely abandoned—possibly too absolutely; but if this latter extreme has been too completely reached, how much less damaging is the excess than that of the school which bled for every and all complaints, and with all the more vigor the more nearly death from hemorrhage had been already reached. Fraser expresses himself in doubt of the correctness of the practice at the time of the Crimean War, thus:—

Hemorrhage with the older and with many of the modern writers, is held to be a great source of danger in lung-wound, and in its arrestment the chief element of success is held to be venesection; to what extent this theory is correct remains to be proved.

It is worth noticing, in reference to this question, that free venesection has been advocated not only for the relief of actual hemorrhage, by inducing fainting, but also to relieve dyspnœa, as we see in the case quoted by Macleod; even further, it has been used as a prophylactic against the occurrence of pneumonia—objects sufficient in number at least to be accomplished by a single remedial measure, how ineffectual for each appears to be amply proved by Fraser's arguments, which first turned the tide of professional opinion into a more rational channel. The experience of wars subsequent to the Crimean, but chiefly that of the American Rebellion, has proved that now the tide sets entirely against venesection in the treatment of penetrating wounds of the chest. In its place, strict attention to the means of obtaining rest, with cold to the surface, and opium, are now the means of treatment.

A question of equal importance with that of general treatment is that of the local management of the wound. The great disturbing cause which seems to have led to uncertainty as to the mode of treatment to be adopted locally, is the fear that collapse of the lung will follow the entrance of air. We find, then, two distinct plans adopted in these cases: (1) the closure of the wound, even "hermetically," and (2) its opposite, allowing the wound to remain open under some suitable dressing. Which is the better? The vast majority of penetrating wounds are gunshot injuries; the exceptions, incised or punctured wounds. Applying the ordinary principles of surgery, even to the case of the exceptional group, nothing but absolute necessity would justify the complete closure of the wound; for all experience proves that, except in the case of such surfaces as those of the divided lip, or the like, accumulation of fluid in the deep part of the wound will take place. Even between the most skilfully cut flaps of an amputated limb, let fluid be pent up, even under the most perfect antiseptic management, its tension will lead to inflammation and local distress—it may be to pyæmia—if no vent be provided. Surely the conditions of a wounded lung and thorax are unfitted for the experiment of closure. We can imagine a clean sword-thrust, or the like, healing throughout, even when it has passed through the edge of the lung; but these wounds are admitted to be even more dangerous than gunshot injuries, from their tendency to bleed, and so to cause fluid accumulations if closed superficially. Nothing appears more repugnant to the principles of surgery than the attempt to close a bullet track, which, however it be placed, under its ordinary conditions, must afford ample material to be discharged externally.

The attempt[1] made to close the external wound by excision of its edges and suturing of the surfaces so formed (Howard), has been extensively tried; but although it has afforded relief at times, and has not always entailed the serious results that at first view one might expect, it has met with the fullest condemnation from those best placed for judging of its results—the surgeons of the American army. The fact of a bronchial drain existing from these wounds seems alone to provide for the relief of accumulation, when the wound is closed either by its form or artificially. Older authorities, Paré and those that followed him, fully appreciated the necessity of a drain from such wounds. Larrey broke in on their plan by the adoption of immediate closure, but his cases were examples of incised wound of the lung, and there existed further an active hemorrhage, calling for immediate pressure for its arrest. In these circumstances the closure adopted for the control of bleeding was found to give relief to the dyspnœa also; just in such cases at the present day would a similar treatment be adopted. But in the case of bullet-wounds, the consensus of opinion among military writers is that the least fatal injuries are lung-wounds in which the bullet passes clean through —less injurious than wounds inflicted by a lesser velocity, in which the bullet lodges. What are the elements of safety added by the second hole? The absence of the foreign body and the establishment of a better drain. Guthrie's observation is an apt illustration:—

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[1] Med. and Surg. History of the War of the Rebellion, Part First, Surgical Volume, p. 497.

General Macdonald, of the Royal Artillery, was present at Buenos Ayres when a bombardier of that corps received a wound from a two-pound shot, which went completely through the right side, so that when led up to the general, who was lying on the ground, he saw the light quite through him, and supposed he was of course lost. This, however, did not follow, and some months afterwards the man walked into General (then Captain) Macdonald's room, so far recovered from injury as to be then able to undertake several parts of his duty before he was invalided; thus proving the advantage of a shot, however large, going through, rather than remaining in the chest.

It may be necessary, therefore, to close a wound, gunshot, incised, or punctured, to command hemorrhage or to relieve urgent dyspnœa, but under other conditions, particularly with gunshot wounds, a patulous orifice is best and most necessary. We find even Guthrie teaching the necessity of being on the alert, in the treatment of incised wounds, to tap, or relieve by counter-opening, on the earliest approach of distress from intra-thoracic accumulation.

The experience of the treatment of empyema, and of wounds in general, makes it very probable that when tested in the service of campaigns, where only a fair comparative estimate can be made, suitable antiseptic measures will be found (in spite of the unfavorable field for them which a bullet-wound of the chest offers) to confer great advantages, while their adoption need neither materially complicate the treatment, nor violate any established principle of surgery.

The annals of military surgery prove, what might *a priori* be asserted with confidence, that penetrating wounds of the thorax, involving both lungs, are almost absolutely fatal. Considering the mortality which attends penetrating wounds of one lung, we need not wonder at this fact. Just enough evidence exists to prove that recovery is not absolutely impossible; but the facts place such injuries only second in gravity to those of the heart and great vessels.

The immediate risks having been avoided in either of these injuries—wound of either or both lungs—there remains, where any hemorrhage has occurred into the pleural cavity (and this must be in all cases except where pre-existing adhesions prevent it), the question as to the behavior of such effusion, and as to its appropriate treatment. Almost as constant as the bleeding into the pleural cavity, is the escape of air from the wounded lung, or its introduction from without. Should the wound be small and oblique, as from the blade of a knife, or from the bullet of a small pistol, the external wound, even when direct, may fail to admit the air, and then the lung-wound is its only source. The risk is from the mixture of air and blood, a necessary result of these injuries, which may lead to the decomposition of the latter; where the air escapes from the lung into the areolar tissue, in fractures of the ribs, it is already by its passage over the bronchial surfaces so perfectly filtered that it appears to be invariably aseptic. In moderate hæmo-pneumo-thorax, originating by the same route, a similar immunity from putrefactive change exists; and, as the experience of operations for paracentesis, apart from the records of military campaigns, proves, even without antiseptic precautions, air, in moderate quantity, may sometimes enter and mingle with a serous effusion with impunity. The experience of practical surgeons with this accident has proved, however, that here the border-land between security and danger is reached: while escape from bad results is possible, even without either air-filter or antiseptic, still the risk is imminent. The multiplicity of devices invented to guard against the accidental introduction of air from without, in the operation for paracentesis, proves the reality of its dangers.

Blood poured into the pleural cavity, as a rule, coagulates rapidly, and will, at first at least, yield but few signs of its mixture with air; therefore Hippocratic succussion is often wanting, or difficult to obtain, in the early stages of these cases; nor is the effort to obtain it either likely to be made, or justifiable, while the desire for absolute rest and freedom from respiratory effort, which such wounds demand, controls both patient and surgeon. The opposite conditions are often present—great oppression, dyspnœa, and orthopnœa—the results of the extreme effusion of blood alone, of air alone, or of both, into the pleura. Between cases of the first group and those of this gravest degree, are a large series in which it has been suggested to favor the accumulation, or rather retention, of blood or of air, to induce pressure in the pleural cavity, as a means of mechanically compressing the lung to arrest bleeding. In the last series, the efforts are made in the opposite direction. It is advisable to make efficient drainage, and even to withdraw the thoracic contents by aspiration to relieve urgent dyspnœa. Just as the lung has been observed to collapse, or again to remain uninfluenced by exposure of the pleural surface to atmospheric pressure, so each of these opposite plans of treatment has, in the first period of penetrating wounds, been found in particular instances to afford relief.

The advocates of "hermetical closure" record many cases of instant relief from the adoption of their method, and while there is abundant proof that the indiscriminate adoption of this practice has been most disastrous, one must be prepared in an emergency to adopt either plan.

Treatment of Pleural Effusions.

It has been clearly shown[1] that blood shed into the pleural cavity coagulates rapidly, and separates into coagulum and serum; that if the amount is moderate, the serum becomes absorbed by the third or fourth day; and that on inflammatory reaction supervening, the change is limited to the circumference of the clot, presently leading to its inclosure in a cyst. But if the amount of blood be great, the serum of the clot is not absorbed when reaction occurs, and empyema results. Air, whether introduced by the wound in the chest-wall or by that in the lung, may equally be rapidly absorbed; if the opening in the lung be small, its sides rapidly adhere, and close by circumscribed effusion of lymph; in these cases, or in those that may be presumed to be such, the closure of the external wound is indicated, but where cases of the opposite kind are the subject of treatment, open wounds, suitably guarded from the introduction of septic material, are to be maintained. In the treatment of traumatic empyema, or of blood-effusion which must from its size and irritating condition terminate as such, the line of practice is not in any respect different from that appropriate to idiopathic empyema; only the cases differ in the fact that already there are external openings, and the proceedings are to be governed by the position and form of these, in arranging for a proper discharge of the retained fluid.

Admitting the foregoing statement, it is clear that the fluid which accumulates in the pleural cavity after penetrating wounds (if we except the rare occurrence of wounds of the œsophagus), may be either blood, serum effused from the pleural surface, or pus. The first and obvious element of diagnosis is the time of development of the signs and symptoms; if these supervene in the first few hours, no doubt can arise, for blood alone can be poured out in sufficient quantity under such circumstances; but delay in the development of symptoms and physical signs does not preclude the diagnosis of blood-effusion, for at any period of these wounds an intermediary or secondary hemorrhage may occur, as it may in wounds of other parts of the body. I have quoted above a marked example of such delay in the development of blood-effusion.[1] An inflammatory effusion, but still serous in character, as has been observed by C. Nélaton, may occasion the signs of pressure and displacement of the thoracic viscera—this fluid originating during the process of the blood-coagula becoming encysted. Lastly, the signs of pressure from fluid effusion may be, and in these conditions are, most commonly due to purulent effusion. If the wound be a bullet-injury, if it be freely open either to the external air or to the bronchial surface, and if a time sufficient for the development of pus have elapsed between the receipt of injury and the development of signs of fluid-effusion, the doubts as to its nature can be but few. Assuming the position or form of the wound to be unfavorable for enlargement, or that the wound has been closed—under these conditions, which must necessarily be the most exceptional, the solution of the problem as to the qualities of the fluid should be determined by an exploratory puncture with the aspirator. The treatment to be adopted will be decided by the result of the exploration. If the fluid to whose accumulation are due the symptoms of intra-thoracic pressure, be blood-serum or serous pleural effusion, its withdrawal with the aspirator—proper attention to cleanliness of the instrument and to the avoidance of entry of air being assured—may suffice to terminate both the symptoms of distress and the formation of fluid. A single tapping may, as was noticed in the discussion of pleural effusion following contusion of the chest, accomplish this object. If the fluid prove to be purulent, further proceedings must be adopted, for with our present knowledge the reproduction of the purulent effusion is a certainty. Temporary relief may be obtained, and in some cases it may be the only object desirable to be obtained, by drawing off a certain amount of pus. A cure without a free discharge of the fluid, which cannot be obtained by the aspirator alone, is an impossibility.

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[1] Ch. Nélaton, Des épanchements de sang dans les pleures.

Of the many devices proposed, there are but two which demand the attention of the practical surgeon: free incision of the pleural cavity, and the more guarded antiseptic evacuation of the empyema, combined with free drainage. Naturally, where wounds exist or are only recently closed, or, though existing, yet fail to provide a free escape for the fluid, a free incision enlarging the original opening will be preferred; but if the wounds are unfavorably placed, a counter-opening in a suitable, dependent position should be made. In making a counter-opening, care must be taken that the point selected is one from which it shall be possible to reach the cavity containing the fluid; to select, in obedience to formal rules, any particular site, must some time lead to disappointment, for an adhesion of the lung, or the presence of encysted coagula, may defeat the object of the operation; if it be possible, the point of incision should be determined, in making counter-openings, by the introduction through the wound of a probe or sound, which, projected against the wall of the cavity from within, may serve to guide the incision. In the case of a closed wound or wounds, so placed as to render this process impossible or unadvisable, a careful physical examination, and a preliminary exploration, should determine the spot for operation. A strange error has been current, that a point low down in the chest, either in front, or at the side or back, should be chosen for the incision, so as to provide for a dependent flow—an incision between the eighth and ninth, or ninth and tenth ribs; but such a position, apart from the risks to the diaphragm and abdominal viscera which it entails, will not be placed in the most dependent part of the pleural cavity, unless we assume that the patient is to spend the period of treatment standing or sitting up. As a man lies, the borders of the fourth, fifth, and sixth ribs, in the line of the posterior axillary fold, or in front of it, are the most dependent points. The opening, if a seat of election is at the command of the surgeon, should be placed, for either free or modified incision, so that, while dependent, it is still convenient to the patient and surgeon. To fulfil these conditions, a position midway between the lines of the anterior and posterior axillary folds seems most suitable, and has proved so in practice. In making the opening, it is necessary to define, if possible, the trunk and main branches of the long thoracic vein, which rather than the artery is apt to give trouble if wounded. This complication is, indeed, more likely to occur in chronic empyema, where the vessel itself and its branches are prone to be enlarged, rather than in the conditions of acute disease attending on a wounded thorax. The accident, too, would be trivial in its consequences, but it would embarrass the operation, and might, with a patient much enfeebled by disease, cause temporary anxiety.

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[1] McDonnell's case, page 800, *supra*.

Assuming that the position of the opening is to be fixed, either at the seat of election above indicated, or where the physical signs may dictate, and assuming further that the opening is to be made without reference to the site of the wound — under these conditions (I have already described the method of operation, viz., a counter-opening made by cutting down on a guide introduced by the wound) there is no difference between the operation as done for idiopathic or for traumatic empyema. The experience of the present day affords ample proof that the proper course to adopt, is to verify the site of effusion by a preliminary puncture, and at the same time to determine with the aspirator the quality of the fluid to be evacuated. The physical signs most to be relied on as indicating the presence of fluid, are the absolute dulness of the part on percussion, the absence of respiratory murmur and sounds, and the destruction of vocal fremitus; without this combination, the surgeon should hesitate to puncture even with an exploring needle; with it, if well defined, he should, before undertaking a more extended operation, add an exploratory puncture to verify the diagnosis, and to gain information as to the kind of fluid. Supposing the fluid to be found a clear serum, as was noted above in a case of contusion of the chest, the evacuation of the fluid, as far as the aspirator will effect it without distress to the patient, or signs of local trouble or obstruction to the tube, may and often does suffice to arrest the disease. In conducting this proceeding with the fine needle, even a valvular puncture effected by slipping the skin to one side while the needle enters, seems unnecessary, for the fine needle makes a wound too small to require the precaution; if its subsequent enlargement is demanded by the character of the fluid, even the slight variation of place caused by the valvular opening is a disadvantage. I assume that, with our present knowledge of the damage causable by the use of unclean instruments, even those least wedded to antiseptic surgery will admit that a scrupulous attention to the cleanliness of the exploring needle is essential, in view of the possibility of the chest-fluid being still only serum, or, if purulent, not as yet infected by decomposing material. To effect the removal of the fluid, should it be found to be serum, repeated applications of the exhausting syringe will be necessary, unless the instrument be one of large size; using the ordinary instrument, which is quite sufficient, it becomes necessary, in order to avoid the accident of entrance of air, that the fittings of Potain's canula, or some such device, shall be adopted, for in the shiftings necessary to empty the receiver, if the tube be not guarded by a proper stop-cock, air will enter, particularly if the patient cough.

Thus far we have considered the conditions which are presented by a case in which a fair presumption may exist that the fluid is serous. In this case its removal is provided for by the adoption of means which are sufficient both for exploration and for the evacuation of a serous effusion. Let us suppose, however, the fluid to be found to be purulent; the exhausting syringe will remove this too, for it flows readily through the fine needle under pressure. Why should not the same means that serve in the case of serous effusion, be applied to it, and the entire purulent accumulation be removed? These means can never remove all the fluid, and while in the case of serum only, absorption will remove the remainder, in the case of purulent effusion the matter will be reproduced, absorption of pus being in practice a myth. To deal then with this emergency, the operator must be prepared with means more efficient than the aspirator. In revealing the quality of the fluid, this instrument does good service; it is an abuse of the instrument to set it to do work beyond its scope. The fluid having been proved to be purulent—a condition most likely, indeed almost a certainty, in penetrating wounds—how is the operator to proceed? Circumstances may be such that antiseptic treatment is impossible, although these must indeed be rare, even in the exigencies of a campaign. Suppose however that such treatment is impossible, or that from the condition of the fluid escaping, say by the orifices of the wound, it is for a time at least superfluous; under these conditions a free incision, made at the point already indicated, passing along the upper border of a rib, should be adopted, and so the freest possible escape for fluid provided. Subsequently, the injection, or introduction by irrigation, of antiseptic solutions may be practised, but at the first, and chiefly, reliance must be placed on a free and dependent incision. If it be admitted that injections to cleanse the cavity are desirable—and all, even the oldest, authors commend them—a suitable antiseptic treatment of the orifice and surroundings of the wound is clearly advisable. Under conditions favorable to antiseptic operation, it has been amply proved that the treatment of an empyema can be accomplished with great success, even in cases of long standing, in which the compression and adhesions of the lung may be presumed to be extensive and fully established. A protracted treatment, extending over many months, has been fully rewarded by the restoration of the lung, and by the permanent closure of the openings. If success of this kind can be obtained in idiopathic empyema, we may fairly expect even greater success in the traumatic form, where the lung's condition (the immediate dangers of the wound having been avoided, as they must have been before an empyema is formed) is more favorable to recovery if life be prolonged through the risks attendant on suppuration.

A strict Listerian treatment may of course be adopted, with a free incision practised as has been above directed, but experience has proved that a less severe and equally efficient method can be employed thus: The chest-wall, at and around the site of operation, being cleansed with a carbolic lotion of a strength of 1—40, and the instruments and operator's hands being likewise duly cleansed, a carbolic spray is made to play fully over the region; an incision, half an inch in length, is then made with a scalpel or lancet over the upper border of a rib, at the seat of election already determined by exploratory puncture, the line of the incision being in the direction of the rib border; a trocar and canula of the size of a No. 12 catheter (English gauge) is thrust through with a smart plunge, guarded by the index finger suitably placed on the canula, into the pleural cavity; the trocar having been withdrawn, as the stream of pus flows, the left forefinger checks the flow for a moment until a full-sized French drainage tube (No. 10, English catheter gauge), fully carbolized, is taken up and held ready to be inserted in the canula; everything being ready, the finger is raised, and the tube passed against the pus-stream into the chest. A full foot at least of tubing should be used to start with. The tube being passed in as far as it will go readily, the canula is withdrawn, while the tube is held in place. The fluid is let flow as long as it will, the spray playing steadily on the opening, but while the entrance of air into the chest is not solicited, no precaution is taken to avoid it; as the fluid drains away, the tube is transfixed with a needle carrying a stout silk thread, or better a link of good salmon-gut, and being held securely by the silk or gut, as the case may be, is cut off flush with the skin, the ends of the ligature being knotted in a safe knot which shall not be liable to slip, and fastened with a slip of isinglass plaster to the chest-wall, at some little distance above the opening. An antiseptic dressing is duly applied and secured, and the operation is completed. It is well not to complete the dressing until all matter which will flow without pressure or effort has ceased to run, for thus a longer interval will be obtained between the operation and the first subsequent dressing.

The advantage of the salmon-gut above either silken thread or silver wire, in retaining the tube in place, is that its stiffness is sufficient to prevent the tube slipping either in or out, while it is pliant enough to prevent irritation by its ends constantly pricking the skin. Nothing should prevent the careful securing of the tube, for it is prone to slip either inward or outward; if inward, it may be difficult to withdraw it, and a thread which is too weak may break in the attempt; or if the knot have been tied in a "granny" it may slip, and thus the tube, as we have seen, may be lost in the chest. If the tube slip out, trouble and inconvenience result too, but of less importance. The form of antiseptic dressing used may be either Lister's gauze, or Thiersch's salicylic jute and cotton, or a combination of both. In the early stages of the case, when the discharge is apt to be great and often variable in amount, the combination appears preferable, as the carbolic gauze, with its included layer of Mackintosh, protects the region of the wound from too direct a stream of air, while the salicylic jute, applied immediately over the wound, yields a constant supply of a non-volatile antiseptic to the fluids passing through its fibres; thus the fluid, should it flow out beyond the margins of the dressing, carries a sufficient amount of the acid with it to prevent its putrefaction—a security which carbolic acid will not give, for its volatility allows the fluids freely exposed to the air to putrefy rapidly. At a later period, when the discharge has become limited and constant, or steadily diminishing, in quantity, an external dressing of salicylic cotton, carefully fixed to the chest-wall, furnishes a perfect filter to the air, entering even directly through its fibres and those of a jute-pad placed beneath. At each dressing, a spray is directed over the region of the wound, and the details are carried out in all respects as in ordinary wounds, except only that the drainage tube is maintained of full size, and pervious, with a free flow of air in and out during the movements of breathing. Should the tube, as the discharge diminishes, become blocked, so that air cannot enter—an accident particularly likely to occur as the disease abates and the discharge is reduced to a few drachms—a change of dressing becomes necessary, for the patient grows uneasy and restless from the defective movements of the chest; as the cavity becomes closed, the tube may be gradually shortened, and at last, after careful examination of the physical signs, withdrawn, but this may only be done when respiratory sounds are audible in close relation to the opening. It is better to err on the side of overlong maintainance of drainage, than to risk a too early removal of the tube. All these processes may extend over a period of many months, but with either dressing, perfect antiseptic results, and finally recovery, may be obtained, with ordinary care and appreciation of the principles which govern such cases.

It has been recommended by high authority,[1] to maintain the drainage of the cavity of the pleura, with antiseptic treatment, by means of a canula of silver accurately fitting the wound, and closed by a silver lid. With this arrangement the fluid is to be washed out by a double tube (two Nélaton's catheters) twice in the twenty-four hours. I am convinced that this method is too complicated, and not in any way superior to the use of a simple drainage tube carried to its full length, shortened when necessary as the cavity fills up, and maintained constantly free for the ingress and egress of air duly filtered by a well-adjusted dressing. Only one trivial point is worth noticing: the ordinary French drainage-tube, perfect in other respects, contains overmuch sulphur; from this no harm accrues at first, except that an uneducated nose may fear that decomposition has taken place, when in reality only the tube has furnished an odor of sulphuretted hydrogen. At a later stage, when the discharge, in a case passing on to a favorable issue, has become serous in character, it will be found that a fresh piece of tubing, used for fear of the old one being decayed or damaged, will provoke a fresh discharge of pus for a few days, by its irritating chemical composition. It is well then to start with two tubes, to have one ready for change at each dressing, and, if it be possible, to avoid new tubes subsequently; better still is the use of pure-rubber tubing, free from an excess of sulphur. As many accidents have happened in the use of pleural injections—notably, in some cases, poisoning by carbolic acid, and sudden and unexplained death in others—it is far better to abstain from their employment; they may be necessary in some cases, but in most they may be entirely dispensed with. The methods of puncture through a rib, which have been of late, and long ago, proposed as substitutes for the opening in an intercostal space, do not appear to offer any substantial advantage. A drainage-tube is always sufficient to maintain the ordinary opening, and it would appear to be only courting a further source of irritation, to establish unnecessarily caries or necrosis of a rib, such as must result from this proceeding.[2]

Doubt has of late years been expressed as to the possibility of *pneumonia* occurring as a result of wounds of the lung, or even contusions of its structure; on the other hand, the statement is made that pneumonia is an invariable sequence of wound of the lung, and constitutes one of the great secondary dangers of this injury. (Erichsen.) In the American war returns, we find that traumatic pneumonia " is noted as a grave complication in two hundred and eighty-five of the penetrating, and seven of the non-penetrating wounds of the chest, and resulted fatally in two hundred and twenty-two of the former and six of the latter group." From these facts it is clear that in the statement of Mr. Erichsen there is an error of excess, for the total number of cases is comparatively small, when we consider the number of chest wounds recorded (20,607). This difference of opinion is, to some extent, due to the various senses in which the term pneumonia is interpreted; it cannot be doubted that neither catarrhal nor croupous pneumonia arises from a wound, but it is clear that an inflammation, tending to suppurative action and to gangrene in the tissues in immediate relation to the wound, occurs, and may implicate a greater or less area of the lung; in this the lung does not behave differently from other tissues. That such is the case, appears very clearly in the following passage:—

> This (gangrene) occurs in case of lesions caused by stabs or gunshot wounds, when under unfavorable circumstances the opening does not heal, but by means of intense

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[1] Fraentzel, Ziemssen's Cyclopædia, vol. iv.

[2] Resection of the ribs for empyema has been already referred to in the article on Excisions, Vol. IV. page 463.

reactive inflammation, with considerable infiltration, the surrounding parts are thrown into suppuration, with the formation of abscess and gangrene. It may also be found to occur from severe contusions of the thorax, for instance, injuries of the shoulder. The elasticity of the chest-wall allows the contusion to act on the lung, and thus to produce effusion of blood followed by gangrenous sloughs.[1]

I have already quoted a remarkable case of this kind in connection with contusions of the chest.

Paracentesis of the Pericardium.

In searching the annals of surgery to discover the relationship of this operation to the subject of injuries of the thorax, the student is forced back to the case of Larrey,[2] for he will fail to find instances in which the operation has been resorted to for the effects of injury since his time; before that period the records of the operation are still fewer—certainly they are silent in relation to wounds. Trousseau,[3] who of all ancient or modern writers is the exponent of the operation, singularly denies a place to the record of Larrey, declaring that both his case and that of Desault[4] are "cases of alleged paracentesis of the pericardium, both originating in errors of diagnosis." While I freely admit that Desault's case was a failure in both diagnosis and result, although it indicates the mode of operation most clearly, I deny that Larrey's case is to be so classed. To him it appears that we must attribute the first operation of paracentesis pericardii—certainly the first, it may be the only one, for effusion the result of wound. It is strange that Trousseau should tell us that Larrey recommended an opening between the edge of the ensiform cartilage and the cartilage of the eighth rib on the left side, a statement approved by Le Fort, and current to-day in the Cyclopædia of Ziemssen, while we find Larrey himself telling us:[5]—

> "J'incisai d'abord la peau et le tissu cellulaire de l'espace intercostal de la cinquième à la sixième côte au-dessous du mamelon et sur le bord inférieur du pectoral; je coupai par couches, et parallèlement à la direction des côtes, les muscles intercostaux. Parvenu à la plèvre costale, je modérai l'action du bistouri, pour ne pas dépasser cette dernière cloison, si le cœur en avait été très près."[6]

Such are the words of Larrey, and yet we find Trousseau asserting that "Larrey believed that it was easier and more convenient to make the puncture between the edge of the ensiform cartilage and the cartilage of the eighth rib on the left side." In his operation, Trousseau adopts the plan formulated by Desault and Larrey, varying the intercostal space only, but making no mention of either of these writers whose method he adopts. Next he considers the operation of Aran, performed with a capillary trocar; this method, though successful in the particular case which he quotes, he condemns as entailing too great risks. As far as the operation and its details are concerned, we have not advanced in these days; certainly in relation to traumatic pericarditis, the question remains as Larrey left it. The American war gives no instance of a wound which gave rise to effusion, relieved, or which should have been relieved, by puncture of the pericardium. Indeed, silence in this matter is perhaps best, for but few have had opportunities for treatment of pericardial effusion by puncture. All are ready to diagnose with precision, in idiopathic cases, the existence of effusion, but none have advanced much further in exactness than Larrey, even though he was ignorant of the use of the stethoscope. I have known the errors of Desault in diagnosis repeated—not indeed to the extent of opening the chest for pericardial effusion—but little short of this; the diagnosis made by the physician, and the case remitted to the surgeon for operation, where no fluid whatever existed in the pericardium. Caution, then, in this matter must lead me to advise, if an operation is to be undertaken, that the surgeon should follow the mode of Desault or Larrey, rather than adopt the puncture with a capillary trocar, as practised by Aran. I freely admit that the modern successes of Allbutt and others in puncturing with the trocar are against this view; but in the uncertainty that must attend the diagnosis of a traumatic pericarditis as compared with the idiopathic form, which is usually the subject of this mode of treatment, I incline to the more cautious practice. [The operation by *incision* is said to have been first practised by Romero, in 1801. It has recently been revived by Rosenstein, Kummell, Partzevsky, and S. West. The literature of pericardial paracentesis, which may be conveniently performed with the aspirator in either the fourth or the fifth intercostal space, has been particularly studied by Dr. J. B. Roberts, of Philadelphia, who has collected 41 cases of which 22 were fatal, but in most instances from causes independent of the operation.]

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[1] Hertz, Ziemssen's Cyclopædia, vol. v. page 412.

[2] Mémoires de Chirurgie Militaire, t. iii. p. 458.

[3] Lectures on Clinical Medicine, New Sydenham Society's Translation, vol. iii. page 364.

[4] Œuvres Chirurgicales, t. i. p. 304.

[5] Op. cit., tome iii. p. 466.

[6] [I divided first the skin and cellular tissue of the intercostal space from the fifth to the sixth rib, below the nipple and along the lower border of the pectoralis; I cut the intercostal muscles layer by layer, and in a direction parallel to the ribs. Having reached the costal pleura, I checked the action of the bistoury, so as not to get beyond that last partition, if the heart had been very near it.]

The oldest method proposed for the puncture of the pericardium—the perforation of the sternum by the trephine, proposed by Riolan—leads us to the complication of chest-wounds for which this operation has been practised successfully, namely the development of abscess in the anterior division of the mediastinum, as the result of fracture or gunshot contusion of the sternum.

Mediastinal Abscess.

Probably the opportunities for the study of this affection as the result of gunshot injury of the sternum are past, for the conical rifle-bullet of the present day will be rarely found to strike and fracture the bone, and fall out of the wound, as in the early cases of mediastinal abscess recorded by Petit. The symptoms which such an abscess give rise to are the development of fever in the early stage of the wound—about the fifth day—or at some more remote period, with rigors; a sense of weight and oppression in the front of the chest, with pain in coughing, drinking, etc.; after the occurrence of cough, breathlessness "as if one had been running;" and more or less œdema over the sternum. With these indications, Petit applied the trephine at the site of the wound with success, giving issue to pus pent up behind the bone. There is no doubt that this treatment was correct, but we may doubt the statement of Petit,[1] that, had it not been adopted, the result would have been fatal; for the area of the sternum is so limited that, in all probability, matter, forming behind it as the result of injury to its tissue, would speedily make its way to the surface at one or other of its borders. Arising in circumstances other than those of injury—as the result of caries, either scrofulous or syphilitic—the matter which forms behind the sternum escapes either laterally or into the neck, or through perforations of the bone either produced by the disease or congenitally present. It is therefore probable that traumatic abscess would take some similar route to the surface. The trephine may be necessary in the later stages of an abscess which has already opened externally, for matter may be retained in the mediastinum, and, the opening being above, as in Lamartinière's case quoted by Chassaignac,[1] a dependent flow sufficient to drain the cavity may perhaps only in this way be obtainable.

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[1] Il n'y a pas lieu de douter que le malade fût mort si on ne lui avoit pas fait cette opération. Petit, Traité des Maladies Chirurgicales, tome i. p. 143.

In the details of examples of shot-fracture of the sternum recorded in the History of the American War, but little prominence is given to the phenomena of mediastinal abscess; indeed, in many there appears to have been but little proclivity to suppuration in the tissues of this region, even though exposed to such an extent as to render "the arch of the aorta distinctly visible." Nor are these injuries in any way foremost in the bill of mortality.

Wounds of the Œsophagus.

In rare instances of penetrating wounds of the chest, the œsophagus has been wounded without lesion of any of its important surroundings. Both in gunshot injuries and in stabs, this accident has happened, the lung and pleura only being wounded in addition. The cases are so few that we are obliged to fall back on the only recorded example, unequivocal in its character, in which recovery has resulted. Boyer,[2] who publishes the case, introduces the subject thus: "Wounds of the œsophagus are very grave, but they are not always mortal. When the wound is limited and is not accompanied by a deep lesion of the lung, the patient may recover."

The case he records was that of an exciseman, aged 24, in robust health, who was stabbed with a bayonet in the upper and anterior part of the right side of the chest, in the discharge of his duty. He ran for his life, followed by the offender whom he had discovered; he ran more than half a league without feeling pain in the wound, but shortly after coughed up some blood. An hour after the accident, when M. Payen saw him, his condition was one of inexpressible agony. He lay on his right side, breathing with difficulty, and with pain in the whole right side of the chest, reaching to the hip. His pulse was rapid, and the least movement was difficult and painful. An angular wound of four lines in extent existed one inch from the sternum on the right side, between the third and fourth ribs. The wound was not bleeding, but at each expiration, and especially during a fit of coughing, the air escaped from it with a force sufficient to blow out a candle seven or eight inches off. The wound was dressed with a compress, and the patient was twice bled at the arm, with relief. Next day the pulse was strong, the pain still acute, the cough less frequent, but the breathing constantly labored. He was bled a third time as freely as before; he had ceased to spit blood. On the third day, when the compress, which had stuck to the wound, was detached, a great quantity of very red fluid, thinner than blood, escaped; after this the breathing became easier. In the evening a similar discharge, equal to the first in quantity, occurred, and of the same character. This diminished the anxiety which had existed. From this time the fluid flowed constantly, escaping by jets when the wound was open and the patient coughed. It continued to flow during many days in such abundance that a great number of towels were soaked in the twenty-four hours. From day to day the color of the fluid was less deep in tint. On the tenth day it was almost colorless. Although the patient drank much, his urine was scanty and very high colored, and loaded with deposit. "I suspected then," writes M. Payen to Boyer, "that the prodigious quantity of fluid which the wound furnished was derived from the drinks, which, instead of passing into the stomach, escaped into the right side of the chest through a wound in the central part of the thoracic course of the œsophagus.

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[1] Traité de la Suppuration, tome ii. p. 330.

[2] Maladies Chirurgicales, 5e éd. tome v. p. 670.

> To test this theory I administered to the patient oily draughts, mucilaginous drinks variously stained, egg-flip, and the like. All these stained the compresses unaltered. Having examined carefully the form and dimensions of the bayonet which had inflicted the injury, I concluded that the wound of the œsophagus must be of very small size, as the weapon must have been stopped by the spine in transfixing it. Two means suggested themselves for treatment—either to use the tube of the stomach-pump to feed the patient, or to stop altogether, or as far as possible, swallowing of food or drink. I adopted the latter, as the simplest and least inconvenient. It was the more easily adopted as the thirst had become less urgent in consequence of the diminution of fever. The patient submitted readily. I permitted him only to clear the mouth, from time to time, with a little flake of orange, and gave him nutrient enemata. Enfeebled by the bleedings and antiphlogistic treatment, the patient experienced at the end of four days cravings that could not be satisfied by the new diet. I yielded to his entreaties, and let him swallow a few spoonfuls of drink. The fluid which the wound yielded was not made more abundant, and presently this discharge was pus only, which I attributed to the entire absorption of the liquid previously extravasated. At last, confirmed by success, I administered nutritive drinks, and finally solid food. . . . . The patient's strength returned slowly, and not before many months was he able to return to duty.

A case illustrating the more probable result in this injury is quoted in the "Leçons Orales" of Dupuytren:—

> A woman was brought to the Hotel Dieu for a deep wound inflicted by a knife above the clavicle of the left side. She died on the seventh or eighth day after her admission. At the autopsy, astonishment was expressed at finding the left side of the chest filled with the drink, and even with some of the solid food, which the patient had taken. The whole was mixed with pus. A large wound existed in the thoracic portion of the œsophagus; the food and drink had not escaped externally, and no sign during life suggested any lesion of this part.

But a single example is noted in the report of the War of the American Rebellion,[1] an instance of laceration without complete penetration of the œsophagus by bullet injury, discovered only by post-mortem examination.

In these examples of this rare lesion, we find no mention of the symptoms of wound of the œsophagus relied on by some—thirst and hiccup (Modière).[2] The positive sign relied on by Boyer remains: "Mais le signe non équivoque est la sortie des boissons et des alimens par la plaie."[3] The objection to the conclusiveness of this sign which has been raised (Knott),[4] that wound of the larynx may be mistaken for that of the œsophagus, in consequence of the escape of liquids which have entered the wounded larynx in individuals suffering from grave depression, applies only to wounds of the neck, not to penetrating wounds of the chest. Wounds of the thoracic portion of the œsophagus by hard and pointed ingesta, its ruptures during vomiting, and the occurrence of ulceration, abscess, or diffuse inflammation of the mediastinum, induced by impaction of angular fragments of bone in the tube, lie outside the range of an article on injuries of the chest, in the ordinary acceptation of the term.

Our knowledge of the phenomena attending the lesions of the intra-thoracic portions of either the *par vagum*, the *phrenic*, or the *sympathetic nerves*, is as yet, as far as regards their relations to the symptoms of penetrating wounds of the chest, too imperfect to justify any conclusions of practical importance. In a similar state is the information at our command regarding wounds of the *thoracic duct*.

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[1] Medical and Surgical History, etc., Part First, Surgical volume, p. 506.

[2] Archives Générales de Médicine, 2e série, t. ii. p. 520.

[3] [But the unequivocal symptom is the escape of drinks and food by the wound.]

[4] Pathology of the Œsophagus.

DISEASES OF THE BREAST.

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It is proposed to consider the Affections of the Breast under the following heads:—

(1) Anatomy of the Breast; (2) Congenital Peculiarities of the Breast; (3) Functional and Sympathetic Conditions of the Breast; (4) Atrophy and Hypertrophy of the Breast; (5) Inflammatory Affections of the Breast; (6) Irritable Breast; (7) Tubercular and Syphilitic Affections of the Breast; (8) Parasitic Affections of the Breast; (9) Affections of the Nipples; (10) Tumors of the Breast; (11) Affections of the Male Breast.

ANATOMY OF THE MAMMÆ.

The chief points of interest to the practical surgeon under this head are the following:—

Connections and Boundaries.—These organs, as is well known, vary much in size and in feel in different women, and at different periods of life, and such variety is the result, in some instances, of functional changes; in others, it is due to the condition and amount of the fatty and other textures covering and surrounding the breasts, and in others again both these circumstances may affect their normal condition. Although these changes in size and feel occur, it may be considered, for all practical purposes, that except in the case of very pendulous breasts, the true glandular substance of the organ retains the same connections under all the alterations referred to.

The exact boundaries of the gland-substance are not always distinctly defined, and it is not uncommon to find processes of the glandular structure passing into the surrounding fatty tissue, and so encircled by it as to appear to be isolated from the breast itself. This fact is of importance in connection with the question of thorough operation in cancer of the gland. The base of each gland, almost circular in shape, rests upon the fascia covering the anterior aspect of the pectoralis major, serratus magnus, and internal oblique muscles, and is connected to it by a layer of areolar tissue. It extends from the third to the sixth or seventh rib, and its greatest diameter is transversely upwards and outwards towards the axilla. It is also important to note that the axillary and central portions are thicker than the other portions, and that one breast—usually the left—is, as a rule, larger than the other. Superficially, the ordinary integument, and more or less fatty tissue, cover the glands, and passing from the former to the latter are numerous processes or laminæ of fibrous tissue, which surround and strengthen the gland-structure. These laminæ, together with the areolar connections of the gland at its base, act in supporting or slinging the breasts, and keeping them in position. M. Giraldès[1] describes the circumference of the fibrous capsule of the breast as being continuous with the superficial fascia, and through it having an attachment to the clavicle, so as to constitute an additional means of supporting these organs. The areola, or skin immediately surrounding the nipple, is thinner than, and differs in color from, that covering other portions of the breast, and after puberty becomes dotted with small tubercles, which have a communication with sebaceous glands, and open externally. Its color is pink in the infant and red in the young adult, but it becomes dark-colored during and after pregnancy, in old age, and sometimes under other conditions. The nipple differs much in development in different persons. In some, it forms a well-marked projection, varying in color from a light red to a dark brown, according to the age and condition of the woman; in others, the organ is small or depressed, or may be absent. The skin covering the nipple is arranged in wrinkles, and is covered by papillæ. Surrounding its base are tubercles, communicating, like those on the areola, with small glands, and at its top are several openings, the orifices of the milk-ducts. In addition to the skin and milk-ducts, the nipple is composed of muscular tissue and numerous bloodvessels, with delicate areolar tissue, and possesses the power of erection, to a greater or less degree in different women.

Minute Structure and Development.—The minute structure of these glands may be described as consisting of numerous lobes, subdivided into smaller lobes, and again into lobules, surrounded, connected, and supported by firm areolar tissue and more or less fat, in which the bloodvessels, nerves, and ducts are distributed. The lobules are vesicles of rounded shape, and from them small ducts arise, which join larger ducts, and these again unite with others so as to form from fifteen to twenty, which pass to the nipple and constitute the milk-ducts. These milk-ducts, when they reach the under surface of the areola, dilate and form small sacs, but at the base of the nipple they again contract and pass to its summit, where they open on to the surface by separate orifices. The vesicles and ducts are lined by epithelium, which is continuous through the milk-ducts with that of the skin covering the nipple.

According to the latest observations, the development of the breasts does not depend, as has usually been supposed, upon an involution of the cells of the cuticular epiblast, but takes place more in accordance with the views of the late Professor Goodsir.[2] Dr. Creighton, as a result of his important investigations in connection with the breast,[3] considers that "the secreting structure is formed in a layer (of mesoblast) beneath the outer skin," and that "the ducts, or communications with the skin, are essentially secondary formations, owing their existence to a force from within." To quote further from Dr. Creighton, his conclusions are:—

> (1) That the mammary acini of the guinea-pig develop at many separate points in a matrix-tissue; that the embryonic cells from which they develop are of the same kind that give origin to the surrounding fat-tissue; and that the process of development of the mammary acini is step for step the same as that of the fat-lobules. (2) That the ducts of the mamma develop from the same matrix-tissue by direct aggregation of the embryonic cells along predetermined lines; that the ducts develop in the individual guinea-pig before the acini, whereas in the phylogenetic succession the ducts

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[1] Mémoires de la Société de Chirurgie de Paris. 1851.

[2] Anat. and Path. Observations. 1845.

[3] Physiology and Pathology of the Breast.

are a later acquisition; and that this reversal of the order of acquisition of parts is in accordance with the principle stated by Mr. Herbert Spencer, that under certain circumstances the *direct* mode of development tends to be substituted for the *indirect.*

ARTERIAL, VENOUS, NERVOUS, AND LYMPHATIC SUPPLY.—The principal *arteries* which supply the mamma are branches of the long thoracic, internal mammary, and intercostal vessels. They vary much in size, according to the functional condition of the organ, and they, as well as the veins, are usually much enlarged when a large or vascular tumor is present. In operating upon the breast it will be found that the chief arteries enter it at the axillary, upper, and sternal margins, and at its under surface.

The *veins* correspond in great measure to the arteries, and pass principally into the axillary and internal mammary trunks. Around the base of the nipple the veins form a special anastomosis, which is termed the *circulus venosus.*

The *nerves* which are distributed to the breasts are cutaneous branches of the anterior and middle intercostal nerves, and these by their union with filaments of the lower cervical nerves constitute a nervous connection with the skin over the breast, in the axilla and inner aspect of the arm, and over the shoulder.

The *lymphatics* of the breast are superficial and deep, and pass, some into the glands of the axilla, some into those in the lower cervical region, and others into those of the mediastinum. It is important to note that the cervical glands may become affected in diseases of the breast without involving the axillary glands, as lymphatics pass directly to the neck, superficial to and beneath the clavicle, and also that the mediastinum and pleura may in the same manner become directly involved in disease passing along the lymphatics.

CONGENITAL PECULIARITIES.

SUPERNUMERARY NIPPLES AND MAMMÆ.—These occur most frequently in the region of the mammæ, but they are sometimes met with in the axilla, and there are on record four apparently authentic cases, in two of which the supernumerary organ was on the back, in one over the acromion process, and in one on the outer side of the thigh. There are also at least two cases recorded in which supernumerary nipples have been situated in the abdominal wall. Numerous individual cases of this malformation have from time to time been reported, but I would especially direct attention to a most full and valuable paper on the subject by Professor Leichtenstern.[1] Dr. J. Mitchell Bruce has also written a most interesting paper on this condition.[2] In the same journal Mr. Cameron describes three cases of this deformity, and refers to many others. During a period of two years and nine months, Dr. Bruce himself observed, in the out-patient department of the Hospital for Consumption, Brompton, sixty-one cases of supernumerary nipples or mammæ, and he expresses the opinion that this malformation is much more common than is usually supposed. The following is Dr. Bruce's general summary of the results of his careful investigations:—

> (1) That sixty-five cases of supernumerary nipple were observed within a period of three years. (2) That of 315 individuals taken indiscriminately and in succession, 7.619 per cent. presented supernumerary nipples. (3) That 9.11 per cent. of 207 men examined in succession presented supernumerary nipples, and 4.807 per cent. of 104 women. (4) That in the great majority of instances the supernumerary nipple was

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[1] Virchow's Archiv, Bd. lxxiii. H. 2.

[2] Journal of Anatomy and Physiology, vol. xiii.

single; that it was without exception situated on the front of the trunk, below and within the ordinary nipple, and more frequently on the left side than on the right. (5) That the distances of the supernumerary nipples from the ordinary nipples are very various, and from the measurement of these distances a series of numbers may be attained which may possibly suggest the unit of distance between the successive pairs of nipples in the original type. (6) That a supernumerary nipple, though frequently well marked, is more frequently small or deficient in one or more of its elements—papilla, areola, follicles, or hairs. (7) That in no case was the supernumerary organ physiologically active, but that in a few cases supernumerary glands appeared to be present (in single women). (8) That inheritance was not traced in any instance. (9) That in more than one instance the anterior abdominal wall was the seat of the abnormality.

It would appear, then, that these supernumerary organs are rarely functionally useful or active, but exist as simple rudimentary appendages. Should a supernumerary mamma or nipple be causing deformity or inconvenience, its excision would be justifiable, but otherwise interference in such cases can rarely be necessary.

Congenital Absence of Mammæ.—A few cases are on record in which one breast, usually the right one, has been entirely absent. In these cases there has been, in addition to the absence of the breast, more or less deficiency of the chest-wall on the corresponding side. In one case described by Froriep, the greater part of the pectoralis major muscle was absent, and the third and fourth ribs were deficient at their sternal ends.[1]

Functional and Sympathetic Conditions of the Mammæ.

Physiologically, it may be said that the function of these organs is to secrete milk in order to furnish nourishment for the infant, but as the secretion of milk occasionally takes place under other circumstances, it may be well to remember the observations of Goodsir,[2] who has pointed out that the functional activity of a gland is identical with the original development of the gland in the embryo. Creighton[3] also remarks "that the continuous and useful production of milk, which alone constitutes the function from the physiologist's point of view, is not the essential or primary activity of the organ, but a mere prolongation of its evolutional force at its highest point." Dr. Montgomery, in his work on the Signs and Symptoms of Pregnancy, refers to cases in which milk has been secreted in the mammæ of young girls, and there are a few rare cases on record in which old women and even men have had a secretion of milk from their breasts.[4] To the surgeon, lactation is principally of interest in connection with the fact that during its progress excessive action may lead to inflammation of the gland or tissues round it, and also with the fact that any obstruction to the passage of the milk along the ducts may lead to tension and inflammation, or to the formation of lacteal or other cysts. The influence that lactation or its consequences has upon the pathology of the morbid growths affecting the breasts, is likewise well worthy of careful study and consideration. It may be well here to note the fact that experience has shown that operations of any magnitude are best avoided, unless there be special urgency, when the breasts are in an excited condition, as during lactation, pregnancy, or menstruation.[5] In the infant the mammæ are surgically unimportant organs, except that after birth they may become a little swollen and tender, and may secrete a small quantity of milky fluid. According to Peddie,[1] the milk is most abundant about the fifth day after birth, and is usually gone by the tenth day. It has the character of the mother's milk at the same period, with colostric bodies as well as milk-globules, but the latter are in sparing number and generally of larger size. It is present in male infants as often as in female ones. The proper treatment of this condition is to soothe the tender part by sponging it with warm water, and to apply over it a little cotton-wadding so as to protect it from any injurious pressure. [The habit which some nurses have of squeezing the infant's breast is to be severely reprobated.] In the girl, the mammæ usually remain in a quiescent state until puberty is established. The time at which this takes place varies under the different circumstances of climate, constitution, education, and social habits. The average age at which menstruation commences is between 14 and 16 years; it may be delayed until 18, and in rare cases until 23 or 24, and it may begin at 11 or 12. There are also rare cases reported in which menstruation has been observed in the infant or young child, with corresponding changes in the mammæ.[2]

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[1] For a detailed and interesting account of this case, see Froriep's Neue Notizen, Bd. x. April, 1839. In vol. xxiii. of the same work, another interesting case is described by Dr. F. Reid.

[2] Op. cit.

[3] Op. cit.

[4] Med. Times and Gazette, 1856; Lancet, 1857; Brit. and For. Med.-Chir. Review, vol. ii. 1852.

[5] Paget, Clinical Lectures and Essays; Smith, Braithwaite's Retrospect, 1876.

After puberty has been established, the mammæ usually undergo some change at the menstrual period, and this varies in degree in different women. The amount of this change depends partly on the development of the organs, partly upon the constitution of the patient, and partly also upon the special condition of her life and surroundings. Ovarian or uterine irritation, or retention of menses, may lead to sympathetic enlargement or irritability of the breasts, in both young and old, and in married and unmarried. The changes to be noted under these conditions consist of some enlargement and tenderness, with occasional discharge of fluid from the nipple. The rare condition of vicarious menstruation may give rise to similar symptoms. The treatment of these affections consists in an endeavor to remove any cause of irritation, uterine, ovarian, social, or mental, the employment locally of soothing applications, the removal of any pressure of the dress likely to increase the irritation, and careful attention to the bowels and general health. In the woman who marries or otherwise parts with her virginity, the mammæ undergo changes; if pregnancy does not take place, the changes, which consist of swelling, tenderness, and knotting of the gland, are usually slight and soon pass off, but when pregnancy occurs, a marked alteration shows itself. The whole gland becomes firm and enlarged, and in some cases there is a feeling of tension and pain, either acute or pricking in character; the areola becomes darker in color and increases in size, and its tubercles are more marked. The nipple also becomes somewhat darker in color and more prominent. It may be well here to note that the changes just described vary in degree in different mammæ when pregnancy takes place. Occasionally little or no change is observed, and therefore the other signs of pregnancy should be studied in determining doubtful cases. The tension of the breast in pregnancy sometimes results in inflammation and suppuration, but this is not common. The condition of the mammæ which results from pregnancy does not often require treatment, but when the symptoms are severe, soothing applications to the breast, protection from local pressure and irritation, and attention to the general health, will be all that is required; if there is any secretion from the nipple, this organ should be carefully washed so as to prevent any scab forming which might obstruct the milk-ducts.

During lactation, cysts or cavities containing milk are occasionally met with in the breast, and these have been termed *Galactoceles*. Gross states that of fifteen such cases, twelve occurred from ten days to seven months after parturition, one sixteen months before childbirth, one during pregnancy, and one twenty-four years after the last pregnancy.[1] They appear to be produced by the dilatation of ducts or sinuses which have been obstructed, or they may be the result of rupture of the canals. Such cysts form tumors, fluctuating or not according to the condition of their contents, which may be fluid or more or less solid. Gross mentions that out of seventeen cases, the contents in seven were pure milk, in two of the nature of cream, in one oil, in one a substance partly curdy and partly fluid, in five a semi-solid caseous matter composed of broken-down epithelium, globules of oil, and acicular crystals of palmitine and stearine, and in one a substance of the nature of butter. They are not usually attended with pain, but occasionally become inflamed. These cysts usually diminish in size when lactation has for the time ceased, but slowly increase during future pregnancies, until removed by operation. The treatment of these cases will depend upon the condition and contents of the cysts. If not causing inconvenience, they may be let alone until lactation is over; if they do not then disappear, and if the contents are fluid, tapping the cyst should first be tried, and if this does not cure, an incision should be made and a drainage tube inserted; when the contents are semi-solid, the cysts should be incised and a drainage tube introduced; when inflamed, they are best treated by free incision.

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[1] Monthly Journal of Medical Science, 1848.

[2] London Med. Journal, 1849.

When menstruation has ceased—and the time for this varies between the ages of 40 and 51, exceptional cases having, however, been recorded, in which it has ended at the age of 30, or not until 55, or even older—the glandular structure of the breasts shrinks or becomes infiltrated with fat, and although the ducts may remain pervious, many of them are mere tubes, having no connection with cavities or acini, which have become obliterated. The pervious ducts are often distended with fluid or semi-solid contents, which, in some instances, can be pressed out through the nipple.

Atrophy and Hypertrophy of the Breasts.

Atrophy of the breasts occasionally occurs in both married and unmarried women, and in such cases the glandular structure is either from the first feebly developed, or becomes atrophied, as in the case of old persons, or persons suffering from ovarian or uterine disease. Such a condition does not admit of treatment.

Hypertrophy of the breasts depends upon an abnormal growth of the glandular structures, and usually commences soon after puberty. It has been met with in single and married women, and generally occurs in both breasts, although one alone has been known to be affected. Breasts attacked by this affection may attain a large size, and so cause both inconvenience and deformity. In some of these cases the breast is pendulous. The elder Gross met with a case in which the breast weighed 15 pounds, and he refers to another case in which the breast weighed 64 pounds.[2] This enlargement of the breast may be simulated by the growth of tumors having some resemblance to the ordinary glandular structure of the part; but in these cases the condition is not one of true hypertrophy. The diagnosis of this disease is determined by the uniform and permanent increase of the glands, occurring in a young adult, and progressing until the size of the organs is beyond that met with during any of their active functional conditions. Birkett[3] describes two forms of the affection; in one, the breast is large and firm, and the skin over it tense and smooth; in the other, the breast is pendulous, and is flat and flaccid. Dr. Guido Banti[1] has written a most instructive paper on this subject. After referring to the observations of Birkett, Velpeau, Virchow, Klebs, Birch, and others, he relates several cases, and specially describes and figures a remarkable instance of hypertrophy of both mammæ in a girl. Both breasts were removed by Dr. Colzi, and the patient recovered. A careful account of the examination of the glands after their removal is also given.

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[1] S. W. Gross, Tumors of the Mammary Gland.

[2] System of Surgery, vol. ii.

[3] Holmes's System of Surgery.

As a result of his investigations, Dr. Banti gives the following conclusions:—

(1) The diseased state, called hypertrophy of the mammæ, exists in two distinct forms. (2) One form constitutes false hypertrophy, which is divisible into three varieties. (3) The other form is a hyperplasia of all the structures of the breast, of the glandular as well as of the connective tissue. For this reason it ought to be termed true hypertrophy. (4) The true hypertrophy and the false are not stages of the same malady, but are entirely different diseases.

Hypertrophy of the breast does not readily yield to treatment, and should attention to the uterine functions and the general health, together with support and careful compression of the organs, fail in giving relief, the removal of one or both of them may be resorted to, but only if the condition is causing serious distress. When both breasts have been affected, the removal of one of them has, in one or two instances, been followed by a diminution in the size of the other.

Inflammatory Affections of the Breast.

Inflammation may originate, as a result of injury or other causes, in the tissues over or near the breasts, without involving them, and this inflammation may or may not be followed by suppuration. In such cases, there is an absence of the characteristic induration of the gland structure, and the inflammation requires the ordinary treatment proper to its origin and nature.

Mammitis and Mammary Abscess.—Inflammation of the mammæ themselves occurs at all periods of life, and may be the result of injuries, such as bruises, wounds, or lodgment of foreign bodies; of sympathetic irritation; of local irritation in connection with the nipple, soft parts over or near the breast, or axillary glands; or of a strumous or weak constitution; but much the most frequent origin is in connection with lactation. In infants, this inflammation is met with soon after birth, and occasionally suppuration takes place, but this is exceptional; it occasionally occurs in young girls; sometimes during pregnancy; but in the large majority of cases in women who have borne a child, and most frequently in those who have been confined with their first or second child. Birkett[2] states that out of 118 cases of either inflammation or abscess, more than one-half had given birth to a first or second child, and nearly one-third were primiparæ; he also observed that out of 116 cases the inflammation commenced during the first month after parturition in half of them, and in a large proportion of these during the first week. Bryant[3] relates that out of 102 cases, 79 occurred during lactation, two during pregnancy, and 21 in patients who were neither suckling nor pregnant; he also mentions that the right breast is more frequently affected than the left, in the proportion of five to three. Defects or affections of the nipple, obstruction of one or more of the ducts, sudden stoppage of suckling, mental excitement, exposure to cold, and feeble health, are the causes which give rise to inflammation during lactation. The usual symptoms of acute inflammation of the breast are, enlargement, hardness, and tenderness of one or more portions or lobes of the gland, and sooner or later redness of the skin over the affected part; there is also constitutional irritation, and there are frequently rigors. The inflammation may confine itself to one or more lobes, or it may involve the greater part of the gland; in cases the result of lactation, the whole gland, or a portion of it, may, in the first instance, be simply swollen and hard, without any marked signs of inflammation. Mammary inflammation may end in resolution, the gland recovering without change; it may result in some thickening of the breast structures; or it may end in suppuration. The progress of the inflammation varies in different cases; sometimes it is very rapid, and it is then usually quickly followed by suppuration, and accompanied by rigors and high fever.

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[1] Archivio della Scuola d'Anatomia Patologica di Firenze, tomo ii.

[2] Op. cit.

[3] Manual for the Practice of Surgery.

When suppuration takes place, as the result of mammary inflammation, it may be circumscribed or diffuse, and it may take place superficial to the glandular structure, in the glandular structure itself, or behind it. Mammary abscesses have, therefore, been divided into superficial, mammary, and post-mammary. The *superficial* form may be limited, or it may spread in the cellular tissue around a considerable portion of the gland; it is not usually attended by such severe symptoms as the other two forms. The *mammary* form may also be limited or diffused; not infrequently, especially in neglected cases, several abscess-cavities exist in the structure of the gland, causing tension and pain, and destroying more or less of its substance, the pus slowly burrowing toward the surface. The local and general symptoms of this condition are often severe.

The *post-mammary* abscess is slow in its progress, and from the position of the pus behind the gland, the latter is pushed forward and projects in a marked manner. In these cases the pus either slowly passes towards the circumference of the breast, generally the lower part of it, and there points at one or more places, or it may gradually work its way through the glandular structure, and point somewhere on the superficial surface over it. It will sometimes happen that more than one of these forms of suppuration exist together, and occasionally both breasts are attacked at the same time or in succession.

The *treatment* of acute mammary inflammation and suppuration consists, in the first instance, in the use of soothing applications in the form of warm fomentations, or lotions of acetate of lead and opium, or belladonna, or poultices. In cases which are the result of lactation, the milk must be drawn off with a breast-pump, and care must be taken to improve the condition of the nipple, and of its ducts, which are sometimes blocked up. It is best to give up suckling the child from the affected breast, but when the mother's health permits, it may be occasionally nursed at the other. In addition to the local treatment, the general health must be carefully attended to, and the action of the bowels promoted by proper medicines. Should portions of the gland remain hardened and enlarged, the affected breast should be supported, and pressure by means of belladonna or other medicated plaster should be made over the enlarged part; in obstinate cases, counter-irritation by the use of iodine or of a blister may be tried if other means fail, and in very chronic cases an antiseptic incision made into the thickened portion will give good results.

When suppuration takes place in connection with the breast, the pus should be evacuated as soon as possible by incision. In superficial abscesses detection of the pus is easy, but in mammary and post-mammary abscesses fluctuation cannot always be recognized until the pus has burrowed its way towards the superficial surface. It is so essential that these deep abscesses should be early recognized and relieved, that in any case of doubt the aspirator-needle or exploring trocar should be freely used, and, if pus be found, an incision should be made without delay. It is only by early incision, in many cases, that destruction of the breast and surrounding structures, and the formation of sinuses and abscess-cavities, can be prevented. When treating a suppurating breast in which there are several such cavities or sinuses, it is important not only to make a free incision at the most convenient, dependent point, but also to introduce the finger and with it break down any thin walls of partition or any adhesions, so as to convert the whole, if possible, into one cavity. More than one incision may be required in these cases, and the introduction of drainage-tubes will often aid in allowing the pus to escape more freely, and will be useful as a means of injecting the sinuses or cavities with antiseptic or other lotions, so as to promote their healthy condition and healing. Incisions made into the breast for the relief of abscesses or other conditions, should run as much as possible parallel to the duct, that is, from the nipple as a centre, especially when made near this process. Should the abscess not have already burst externally, I would strongly urge, from considerable experience, the importance of employing careful antiseptic measures in its treatment. In cases which are not aseptic, the thorough cleansing and scraping of the walls of the abscess-cavities and sinuses, and the application to them of De Morgan's solution of chloride of zinc (forty grains to the ounce), or of tincture of iodine, will usually promote a healthy action and quicken their contraction and healing. In aggravated cases in which the glandular substance is in great part destroyed, it will sometimes be useful to remove the whole suppurating mass, saving as much of the skin as possible. Patients suffering from mammary abscess who are feeble in health, or who have become weakened and exhausted by irritation and continued suppuration, must be supported by good, nourishing diet, suitable to their condition and powers of digestion. Stimulants are not as a rule required if the food is digested, but they should be given when there is great weakness or difficulty in assimilating ordinary nourishment. Quinine, iron, cod-liver oil, or other tonics, must be prescribed, if the case seems suitable for them, and carriage-exercise in the open air will often aid in improving the health, provided that proper means be taken to prevent any undue exposure to cold.

MILK FISTULÆ.—As a result of abscesses involving the breast, one or more sinuses communicating with the gland-ducts may remain open and allow the milk to escape through them ; if such sinuses do not contract and heal, they should be treated by injections of chloride of zinc or iodine; and if this fails to cure them, they should be opened up and drainage-tubes inserted along their whole extent, while at the same time the affected breast must be supported, and, if pressure can be borne, this should be applied over the track of the sinuses; as these contract, the drainage-tubes must be correspondingly shortened from time to time.

CHRONIC INFLAMMATION AND ABSCESS.—As a consequence of acute inflammation—or from some irritation, local, functional, or sympathetic—one or more portions of the breast may become chronically inflamed. In such cases the affected portion is thickened, hard, and sometimes tender to the touch ; this condition may remain without much change, it may slowly disappear and the inflammatory products be absorbed, or it may end in the formation of a chronic abscess which may be very slow in its progress, and, if situated in the breast-structure, may be long before it points towards the surface.

Counter-irritation, gentle pressure by means of a belladonna or other plaster, support to the gland, and attention to the health, will generally relieve such swellings. If there be any doubt as to the existence of fluctuation, aspiration will decide the point, and if an abscess be present, it should be opened antiseptically at a convenient point.

LYMPHATIC INFLAMMATION.—Velpeau, in his treatise on the diseases of the breast, describes a special form of lymphatic inflammation, and gives the following symptoms as characteristic:—

> 1. Irregular chills, sometimes a downright shivering fit; a rapid and tumultuous pulse, which is unequal rather than strong; heat of the skin; restlessness; loss of sleep and appetite; and sometimes nausea.
>
> 2. In the breast there are pain, great heat, swelling, and red patches irregularly scattered about, coming to a focus in painful spots, more or less raised from the surface.
>
> 3. Generally there is a painful state of the axillary glands, and sometimes reddish striæ lead from the breast to the armpits. Chaps, excoriations, eczematous eruptions, abrasions of the skin, and all affections of the nipple and areola, are the ordinary causes of lymphatic inflammation of the breast.

The treatment of this condition is that of the other forms of acute inflammation of the breast.

IRRITABLE MAMMA, OR IRRITABLE TUMOR OF THE MAMMA.

In this affection the whole breast, or a portion of it—most frequently the latter—becomes hard and tender to the touch. In some cases the principal symptom is tenderness, without much apparent hardness. The condition is most common in unmarried women, or in married women who have no children, and is often troublesome in regard to its satisfactory treatment. When thickening of the breast-structure exists, the affection may be aggravated by constant examination and handling on the part of the patient, often caused by the fear that the disease is something of a more serious nature. All varieties of the irritable breast are not infrequently attended with some irritation or disorder of the ovarian, uterine, or digestive functions. Some mental excitement or depression is also a common accompaniment of this affection. It is important that cases in which there is induration of the breast-structures should be accurately diagnosed from cases of morbid growth, and experienced surgeons know that the diagnosis between the two is sometimes difficult. The following are the best means of distinguishing these simple indurations:—

1. Inquiry into the history of the case will show that there is no steady increase in size, such as occurs in the case of morbid growths.

2. There is usually much more pain and tenderness than is common in morbid growths.

3. They are not circumscribed, as in the case of simple growths, and their hardness is not as marked as in the case of scirrhus. A special means of distinguishing between the hardness of simple induration and that of scirrhus, is to press the swelling steadily against the ribs, when, in the case of the former, the hardness will be very slight, but in the case of the latter it will be well-marked. Both forms of swelling, when grasped laterally, often feel equally hard; but when pressed backwards, as has been described, a decided difference is recognized.

Mr. Birkett gives as a diagnostic sign in these cases the fact that "pain usually follows the course and distribution of one or more nerves, and that if these nerves be sought for and pressed upon, as they issue from the thorax, the slightest pressure will induce acute pain, sometimes confined to a single branch distributed to the indurated part, while the rest are unaffected."[1]

4. The general condition and temperament of the patient are often significant.

5. Under treatment the symptoms will be relieved in the majority of cases.

Should the diagnosis of this affection be doubtful, the best means of determining its nature is to make a small incision, with antiseptic precautions, into the hard part, and if necessary remove a small portion for microscopic examination.

It is so important that an accurate diagnosis should be made, not only in connection with the treatment of the disease, but in order to relieve the mind of the patient, that I would urge this proceeding in all doubtful cases. If the case be one of simple induration, the incision will probably do good, and if it should turn out to be one of morbid growth, an operation for the removal of the disease will be recommended with more confidence. The treatment of this affection consists in attention to the general health and restoration of any disordered functions, encouragement of the patient by an assurance that the disease is simple in its nature, and the local application of belladonna, a lotion of acetate of lead, or other soothing remedy. If the induration is well marked and the soothing means do not succeed in relieving it, counter-irritation and pressure should be tried, and if the condition still persists and is causing severe symptoms, a free incision into the swelling will be the most likely means of effecting a cure. When the hardness and symptoms continue severe, and when the patient is middle-aged, or older, excision of the swelling would be wise; for such a continued local irritation may undoubtedly develop some form of epithelial cancer.

Tubercular and Syphilitic Affections.

The breasts may become involved in connection with *tubercular* affections of the cellular tissue, lymphatic glands, or bones in their neighborhood, and thickening, ulceration, or abscess of their glandular structure may result.

Deposit of tubercle occasionally takes place in the gland itself, as has been described by Velpeau; and such a deposit causes enlargement of the breast or of a portion of it, and this may or may not be followed by the characteristic suppuration and destruction of tissue. Such an affection requires the general and local treatment which is found most useful in tuberculosis.

Syphilitic affections of the skin, cellular tissue, periosteum, and bone in the neighborhood of the breasts, may involve those organs, and cases of syphilitic enlargement of the breasts themselves have been recorded by Dr. C. Ambrosoli.[2] This form of enlargement consists in a more or less general hypertrophy of the gland, with uniform induration of its tissues.

The affection occurs in syphilitic patients, sometimes attacking both breasts, sometimes only one, usually at the end of the secondary or at the commencement of the tertiary period. The characteristics of this syphilitic enlargement are, that the hardness is uniform, smooth, and not very painful, and that it yields to antisyphilitic treatment. The use of iodide of potassium internally, and, if this fails, of mercury in small doses, together with gentle counter-irritation and pressure, constitutes the treatment of these cases.

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[1] Holmes, Principles and Practice of Surgery, p. 825.

[2] Ranking's Half-yearly Abstract, vol. xlii., 1865.

Parasites Affecting the Mamma.

Dr. Haussmann, of Berlin,[1] has given an important account of the parasites met with in the breast. The only animal parasite the presence of which in the breast he has been able to authenticate, is the Echinococcus. From an examination of the reported cases, Dr. Haussmann is of opinion that the cyst caused by this parasite never involves the nipple or its immediate neighborhood, but that it may occur in any other part of the gland. There may be a single cyst, or a cyst containing from one to four or five others; a multilocular hydatid cyst has never been reported as met with in these organs. Landau, of Breslau,[2] records a case in which the cyst communicated through the ribs and intercostal muscles with the cavity of the chest or abdomen. The symptoms of this affection are a smooth and fluctuating swelling of slow growth, causing usually no symptoms except a little pain in the axilla and arm of the affected side. This rare condition may simulate a simple serous cyst of the gland, but aspiration or tapping would reveal the characteristic fluid and contents, in the case of an hydatid cyst. Inflammation and suppuration in the tissues outside the cyst-wall may take place, and this may be followed by a bursting of the cyst externally, escape of its contents, and a spontaneous and gradual cure of the disease.

The treatment of this condition is to make a free incision into the cyst, and to introduce a drainage-tube and retain it for some time. Should this not cure, the cyst may be excised; but from my experience of the treatment of hydatid cysts in other external parts of the body, I am disposed to think that the more simple treatment will usually suffice.

Affections of the Nipple.

Inflammation may attack the nipples and surrounding skin, causing excoriation, ulceration, or fissure. This condition is most commonly met with in connection with pregnancy and lactation, but it may occur from any form of local irritation. It may give rise to much painful smarting and suffering, and in severe cases to general disturbance, and it is especially troublesome in the case of nursing women. The ulcers or fissures may be deep, and may destroy the skin so as to leave the nipple only attached to the breast by the lacteal ducts. Obstruction of these ducts may result, and may lead to the formation of abscesses.

Treatment.—In cases of simple irritation and excoriation, the parts should be kept clean by carefully washing them with warm water and soap, and some astringent lotion should be applied. Cologne-water, spirit of wine, and strong infusions of tea, catechu, or other astringents, are advised for this purpose. A mixture of gr. x of nitrate of lead to ℥j of glycerine has also been suggested. Playfair advises equal parts of sulphurous acid and glycerine of tannin, with twice the quantity of water; and Leishman, an ointment consisting of gr. iij of tannic acid, ʒss of glycerine, and ℥j of spermaceti ointment. When the fissures are deep and painful, touching them with solid nitrate of silver, and leaving the resulting scab uninterfered with until it loosens and falls off, is one of the best methods of treatment. If suckling causes great suffering and interferes with the healing of the fissures, a zinc nipple-shield may be used, or suckling may be given up altogether on the affected side. It is important to note that if the breast is being used for nursing, all applications of a poisonous nature must be carefully washed off before the child is put to the nipple.

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[1] Med. Times and Gazette, vol. ii. 1874.

[2] Archiv für Gynäkologie, Bd. viii. 1875.

Retracted Nipples.—The nipples may be small and retracted congenitally, or owing to the pressure of stays or other portions of dress, or to contractions of the breast-structure from inflammatory causes or the presence of tumors. Such a condition may cause much trouble in connection with suckling, and by leading to obstruction of the lacteal ducts. When due to the first two causes mentioned, it may sometimes be relieved by regularly drawing out the nipple with the fingers or sucking-glasses. The application of a shield, with tube attached, will occasionally assist in allowing the child to be nursed.

Tumors of the Breast.

All practical surgeons are aware of the difficulty, in the present state of pathological knowledge, of making a correct classification of tumors. In the case of the breast, as in the case of other organs, tumors affecting it, which were once considered to be simple or benign in their characters, are now known to be as malignant in their tendencies as are the true cancers. It is unfortunate, too, that, owing to defective pathological study, different terms have been applied to the same kind of growth, while on the other hand growths of an entirely different structure have been classed under the same term, owing to their having some resemblance to one another in their external characteristics.

The case appears to stand thus: Pathologists have, by improved microscopic study and other research, determined that tumors formerly supposed to be identical, vary much in their development, structure, and tendencies; but practical experience is not yet sufficient to enable the diagnostic symptoms and behavior of all these varieties to be accurately described by mere clinical study and external examination. Under these circumstances, an attempt can only be made to study the subject of tumors of the breast in their pathological and clinical aspects, as far as present experience exists. In order to do this as practically as possible, it is proposed to employ the terms *simple* and *malignant*, and to classify under these heads the tumors that affect the breasts. I am aware that this classification is imperfect, and that tumors which may be considered of a *doubtful* nature must be included under one or other of these heads; but the term "semi-malignant," which is sometimes used, scarcely expresses the true behavior of such growths.

Professor S. W. Gross, in his recent and valuable work, a study of which has been most interesting and useful to me, suggests the following combined genetic and anatomical classification of tumors of the breast:—

(A)

1. Neoplasms derived from the periglandular connective, and constituted by connective tissue or its equivalent, of which two divisions may be made, namely:—

(*a*) Those which represent perfected or matured connective tissues, and may, therefore, be called typical. These comprise fibroma, or fibrous tumor; myxoma, or mucous tumor; lipoma, or fatty tumor; and chondroma, or cartilaginous tumor.

(*b*) The second division includes those neoplasms which represent embryonic, unripe, or transitional connective tissue, and may be termed atypical. It is limited to the genus sarcoma.

2. Neoplasms which proceed from the secreting elements, and are composed of epithelium. Of these, adenoma, or glandular tumor, is a typical epithelial growth, while carcinoma is an atypical epithelial formation.

3. Neoplasms which are derived from and are constituted by higher structures.

These are, first, angeioma, or a tumor consisting of bloodvessels; and, secondly, neuroma, or a growth made up of nerves.

(B)

Cysts, which include the formations due to obstructions of the ducts and the accumulation of the secretion of the lacteal glands, and cysts of new formation, including echinococci.

Dr. Gross also expresses the opinion that—

The development of the neoplasms of the breast is connected with the changed proportions of the component tissues of the breast at different periods of life, and that the condition of the tissue is, as a rule, indicated by the age of the patient.

He further remarks that—

The non-carcinomatous growths occur on an average at the thirty-third year; only 30.37 per cent. develop after the age of forty, when the physiological life of the mamma is beginning to be impaired; 15.22 per cent. appear before the twentieth year; and 5.18 per cent. are met with before the establishment of menstruation. Previous to the age of forty, or during the structural perfection of the gland, or when the proportions existing between the epithelial and connective-tissue constituents is normal, fibromata and sarcomata are the most common neoplasms.

From the same statistics he also infers that—

Structural perfection of the mamma renders it most obnoxious to fibroma, sarcoma, and adenoma, while atrophy or decay predisposes it to myxoma and carcinoma.

I. Simple Tumors.

Fatty, Vascular, Nervous, and Cartilaginous Tumors.—*Fatty tumors* are occasionally met with in the cellular tissue round the breast, but they do not affect the breast itself. *Vascular tumors*, affecting the breast, have been recorded by Bryant, Image,[1] and Langenbeck.[2] Two cases of *neuroma* in the breast have been reported by Tripier.[3] A few cases of *cartilaginous tumor* of the breast are also on record. The best recorded case is that of Dr. Lange.[4] The tumor was removed from the breast of a woman, 51 years of age, and, according to Dr. Lange's account, "consisted of true cartilaginous and osseous tissue, the former mostly in its variety as hyaline cartilage. One large, roundish division, about one and a half inches in diameter, contained a large, bony nucleus. Otherwise the tumor consisted of a number of smaller, roundish divisions, separated from each other by strong layers of fibrous tissue, and showing partly glandular structure with cartilaginous nuclei scattered."

These various tumors do not require any special remarks in regard to their treatment. Should they, from their symptoms or bulk, cause inconvenience, they must be dealt with according to the ordinary principles of surgery.

Cystic Tumors.—These may be divided into (1) Single Cysts; (2) Multiple Cysts. Cysts are also met with which contain solid growths in their interior—the so-called "sero-cystic" tumor of Brodie, the "proliferous cyst" of Paget, and the "cystoid-adenocele" of Birkett—but these may be more properly classified in reference to the special forms of growth which are contained in them.

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[1] Med.-Chir. Trans., vol. xxx.

[2] Nosologie und Therapie der chir. Krankheiten, Bd. v. S. 83.

[3] Dict. Encyclop. des Sciences Méd., 2e série, t. iv. p. 408.

[4] Med. Record, 1881.

(1) *Single Cysts.*—Single cysts may occur at any part of the breast, but are most common in the region of the nipple, or in the substance of the gland near it. The contents of these cysts vary: they may consist of clear serum, of serum mixed with blood, or of a fluid, brown or yellow with scales of cholesterin. I have occasionally seen the fluid of a greenish color. The walls of the cyst are generally thin, and occasionally they undergo calcification. These cysts may occur in married or unmarried women, but they are more frequent in the former. Their size varies from that of a small marble to that of a large orange. One case is recorded, of a cyst from which nine pounds of serum were evacuated. A very common size is that of a small walnut. Inflammation and suppuration of these cysts have been recorded, but they are rare.

Diagnosis.—There is a circumscribed swelling, regular in shape, fluctuating, and unattended with any inflammatory signs or any marked hardness of the surrounding breast-structure. The feeling of fluctuation is not always distinct, as the cyst may be tense, forming a firm and somewhat elastic tumor. These cysts may be superficial, and in such cases the skin becomes gradually thinned over them, so that the swelling can be seen to be more or less transparent. In some cases there is a discharge from the nipple in connection with this condition. As it is sometimes not easy to distinguish these cysts from solid growths, a fine trocar or aspirator-needle may be introduced in order to decide the question. The tendency of these cysts is to increase slowly in size if not interfered with; occasionally, however, they increase rapidly.

Treatment.—Puncture and evacuation of the contents of the cyst, and afterwards pressure over its cavity. If there should be any thickening of the tissues round the cyst, the application of a blister over the swelling is usually beneficial.

If simple puncture and counter-irritation fail to cure the cyst, it is best treated by means of a small incision with antiseptic precautions, and the introduction of a drainage-tube. In puncturing these cysts it is important to fix them with the fingers, because, when movable and tense, the trocar or needle may fail to enter the cavity if this precaution be not adopted. Excision of a single cyst is rarely required.

(2) *Multiple Cysts.*—Two varieties of these are met with: one in which numerous cysts varying in size are scattered through the substance of the gland, and the other in which two, three, or more large cysts exist, and are grouped together. In the former, there is usually some thickening of the breast-structure in the neighborhood of the cysts; and in the latter, the glandular structure has usually partially or wholly disappeared. The contents of multiple cysts vary, and are similar to those met with in single cysts.

Diagnosis.—There is a nodulated, irregular condition of the breast—the nodules being felt as small, firm, elastic swellings, in which, on careful manipulation, fluctuation can usually be detected—with some thickening and knotting of the breast structure. Or there is a swelling, irregular in shape, with distinct and separate fluctuation at more than one point, and more or less absence of the gland-substance. There is sometimes a discharge from the nipple, and in some cases the skin is thinned, and shows transparency.

As in the case of the single cyst, the tendency of the multiple cyst is to increase in size, and it occasionally becomes inflamed and suppurates.

Treatment.—In the case of a tumor composed of two or three large cysts, and confined to one portion of the breast, an attempt should be made to cause their obliteration by incision and careful drainage; but when the cysts involve the greater portion of the breast, or are scattered through its whole substance, excision of the entire breast is the only satisfactory remedy. If the cysts are small, not increasing in size, and not causing any annoyance, operative interference may be delayed until they become troublesome.

Adenomata and Fibromata.—These growths, which are composed of connective tissue in a more or less perfect or embryonic state, may be classed together, because, as a clinical fact, it is not usually possible to distinguish them from one another until they have been subjected to microscopic examination.

A purely *adenoid tumor* is of very rare occurrence, and may be described as a growth composed of fully developed glandular tissue, such as is met with in the physiologically active mamma.

The *fibroma* may be described as a tumor mainly composed of fibrous tissue in a more or less developed state, and containing in the majority of instances some adenoid or glandular structure in its substance; hence such tumors have been termed by some, fibro-adenomata. These tumors may be considered innocent in their nature, and are separated from the breast-structure by a well-marked fibrous capsule. Two varieties are met with: first, the solid; second, the cystic. The solid tumor is met with as a circumscribed, firm, elastic swelling, usually lobulated, but with the lobules sometimes so small that the tumor feels smooth and regular. It is most frequently situated superficially, below the nipple, or at the axillary margin of the breast; but it also occurs in the substance of the gland itself; and I have met with two cases in which the tumor formed a prominent swelling behind the breast. Occasionally these tumors have been found to be pedunculated; and, wherever situated, their capsule is more or less adherent to the breast-structure. Their growth is usually slow, but it may be somewhat rapid, especially in the cystic form; and their size varies from that of a bean to that of a child's head. It has occasionally been observed that these tumors increase temporarily in size during menstruation and pregnancy. There can be no doubt that they may become smaller, and that they may even disappear spontaneously.

According to my experience, these tumors are most frequently met with in young adults, but they may occur at any age, from twelve to sixty. They are usually single, but multiple growths are sometimes met with. In the cystic form the growth is usually distinctly lobulated, has a tendency to grow more quickly than in the solid form, and is firm to the feel at some points and fluctuating at others. Growths varying in form and color spring from the inner wall of the cyst, and in not a few cases there is some discharge from the nipple. This variety of the growth is more frequently met with at a later age than is the case with the more solid variety. These tumors occasionally inflame, suppurate, and fungate, more particularly in the cystic form. A large, fungating, solid fibroma has come under my observation, but the ulceration and fungation in this case were the result of a quack application. Calcareous and other changes also affect these tumors, and I have removed a fibroma which had become almost entirely converted into a calcareous mass.

Diagnosis of the Solid Form.—A firm, elastic, circumscribed, and more or less lobulated tumor is observed, usually of slow growth, having the skin and other tissues over it freely movable, and showing no signs of discoloration. As has already been mentioned, it is common to find these tumors adherent at one point, usually in their deeper relations to the breast-structure.

The *cystic form* constitutes a tumor distinctly lobulated, varying in degrees of solidity and fluctuation, circumscribed, and in some instances attended with discharge from the nipple. According to Gross, in one of every seven cases there is discharge from the nipple, and there is a tendency to fungate in the same proportion.

Treatment.—If causing irritation or much mental distress, or if increasing rapidly in size, excision of the tumor alone is the best treatment. Pressure by means of pads, and the application of plasters, have been employed, but without much good resulting; and, as these tumors are movable, it is very difficult to apply direct and continuous pressure to them. If the growth is large and the breast structure atrophied, excision of the entire gland and tumor will be the most satisfactory proceeding. Although these tumors may be considered, as a rule, innocent in their nature, they do occasionally soften and enlarge, and simulate malignant growths in their progress. It has also been occasionally observed, that, after their removal, a secondary growth with malignant tendencies has been developed in the situation of the original tumor. The most probable explanation of the latter cases is that referred to by Paget, who considers that these secondary tumors are really cancers developed independently, and in some instances as the result of the local irritation produced in connection with the original growth.

The pure adenoma occasionally recurs after operation, but usually locally, as in the neighboring glands. Secondary growths must be removed, should the condition of the patient warrant an operation.

II. Malignant Tumors.

Sarcomata.—Although there is a difference of opinion as to the degree of malignancy of these tumors, the most recent investigations tend to prove that many of them are as serious in their characteristics as the true cancers; and that although others are not so serious in their nature, they can scarcely be termed benign. The whole subject of these tumors, as they occur in the breast, is in a somewhat unsettled state, but Dr. S. W. Gross has brought together many interesting and important facts, which will assist in clearing up the matter, and in placing our knowledge on a more practical basis.

The sarcomata which affect the breast may be solid or cystic, and their structure may be *round-celled*, *spindle-celled*, or *giant-celled*. In some instances —about one-third of all sarcomata, according to Gross, and more especially in the spindle-celled—glandular or adenoid structure exists. The inter-cellular substance in the various sarcomata differs, and leads to variations in the pathology and consistence of these growths. Fatty, cystoid, calcareous, and other changes likewise take place, and, like other tumors, they are also liable to become inflamed and to suppurate.

The spindle-celled variety is by far the most common. Out of 60 cases of sarcoma of the breast collected by Gross, 45 were spindle-celled; and out of 16 cases which came under the notice of the same surgeon, 11 were of this character. According to the same author, six-tenths of all sarcomata in this region are cystic, and in one out of every seven of these there is discharge from the nipple.

Sarcomata are, in the large majority of cases, single in the first instance, and they are usually of more rapid growth than fibromata; but there appears to be considerable diversity in this respect, as some tumors have been known to remain of small size for several years, while in other instances a tumor has grown to the weight of several pounds in a few months. It has also been observed that these tumors are sometimes subject to a sudden and rapid increase; and Gross notices the fact that during the active growth of sarcomata, there may be elevation of the general temperature.

Diagnosis.—As these growths are usually encapsuled, and form circumscribed tumors in their early stage, they are not easily distinguished from the fibromata, but their progress and future behavior will in time reveal their true nature. Their shape is rounded or oval, with more or less lobulation, and their feel is firm in some cases (the spindle-celled), soft and elastic in others (the round-celled); but alteration in structure, or degeneration, may cause either of these varieties to be modified as regards its consistence. In the cystic variety, the growth is partly firm and partly elastic to the feel, and in the majority of cases occurs at an earlier age than in the solid form, and more particularly in the case of cystic, spindle-celled growths. Sarcomata may or may not be attached to the breast structure; frequently they push it aside, or cause it to atrophy. The skin over these growths remains movable and unaffected for a time, but when the tumor increases the skin may become thin, and ulcerate. As the growth progresses it may not only involve the skin, but may fungate, infiltrate the surrounding textures, and affect the internal organs. In connection with the diagnosis of these growths, I think it well to give the following quotation from the work of Dr. S. W. Gross, already referred to:—[1]

> The diagnosis of small, slowly increasing, fibrous sarcomata is by no means easy, as they are very liable to be confounded with fibromata, particularly when they arise at the circumference of the mamma. A tumor, however, of soft, elastic, apparently fluctuating consistence, which attains the volume of an adult head in a few months, can scarcely be anything else than a small-celled sarcoma. On the whole, the diagnosis is based upon their indolent origin, mobility, central situation, elastic or unequal consistence, lobulated outline, rapid increase, large dimensions for the period of their existence, freedom from lymphatic involvement, and marked tendency to ulcerate; upon the not infrequent discoloration of the skin, enlargement of the subcutaneous veins, and, possibly, elevation of temperature; upon the suffering which they awaken late in the disease; and upon their greatest frequency after the thirty-fifth year. Between the solid and cystic varieties there are certain distinctions which are useful in establishing a differential diagnosis. The former develop at about the thirty-seventh year; the skin is discolored in 16 per cent. and adherent in 12 per cent.; the veins are dilated in 8 per cent.; there is no discharge from the nipple; pain is met with in 30 per cent., but is slight; the tumor ulcerates in 12 per cent., and is characterized by malignant features in 77 per cent. of all instances. Cystic sarcoma starts at the thirty-third year, it grows more rapidly than the solid variety, and its increase is often sudden after having remained stationary or advanced slowly for some time. Now and then, after evacuation of the fluid of the superficial cysts, their solid contents can be detected by manipulation. The consistence of cystic sarcomata is, as a rule, unequal, and they are more largely lobulated than those of the former variety. The skin is discolored in 34 per cent., being of a bluish tint in one-third of all cases over the most prominent cysts; and it is adherent in 11 per cent.; the veins are enlarged in 25 per cent.; the nipple is retracted in 5.71 per cent., and discharges fluid in 14.28 per cent.; ulceration occurs in 34.28 per cent.; pain is experienced in 78 per cent., and it is usually harassing, while the disease is malignant in 64 per cent. of all cases.

After the removal of these growths recurrence takes place locally, not as frequently as in cancer, but more frequently than cancer in the internal organs. Gross states "that mammary sarcoma recurs locally in 61.53 per cent. of all instances, and that it gives rise to secondary deposits in distant organs in 57.14 per cent." "In carcinoma, on the other hand, 88.35 per cent. of the local recurrences are met with in the first year, while only 50 per cent. of the cancers affect distant parts."

Treatment.—Early and free removal of the tumor and surrounding textures, and, if the tumor is large or seriously involving the breast-structure, excision of the entire gland along with the growth. Recurrent growths should be at once removed if no visceral complication be detected; for such removal certainly prolongs life, and lessens the risk of further infiltration or involvement of internal organs.

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[1] Op. cit., p. 99.

CARCINOMATA.—Considering cancer as a new formation, generally now described as an atypic, epithelial growth, which tends to infiltrate the tissue in which it originates, to involve the surrounding textures, and to affect the lymphatic glands and internal organs, it may be held that the varieties of cancer, and the modifications met with in some of them, depend upon the conditions of their cell-elements, and upon the character and condition of the stroma in which the cells are contained. There is a considerable difference with regard to the rapidity of progress, and the date and nature of involvement of surrounding tissues, lymphatic glands, and internal organs, in cases of cancer of the breast: and there is also a considerable difference in connection with the occurrence of general cachexia in patients suffering from this disease. In some instances cachexia is from the first well marked, while in others it occurs only late in the progress of the malady. For practical purposes the varieties of cancer affecting the breast may be divided into *scirrhus*, or hard cancer, and *encephaloid*, or soft cancer. *Colloid* cancer has, in rare cases, been met with in the breast as a primary growth, and it occasionally occurs also as a form of degeneration in other tumors. When met with as a primary growth it is not at first easily distinguished from other slow-growing tumors, unless there is an opportunity of examining its structure microscopically. Clinically, it is characterized by its firm consistence, chronic nature, and slowness to involve lymphatic glands, surrounding tissues, or internal organs. It has been met with at the age of 28, and as late as 66 years—the average being 45 years (Gross)—and it does not usually attain a large size. The frequency of the different varieties of cancer in the breast, according to the cases tabulated by Prof. Gross and Dr. Henry, may be stated as follows:—

Out of 100 cases there were of:—

Ordinary scirrhus	77
Simple carcinoma	11
Atrophic scirrhus	7
Encephaloid cancer	5

Of 59 cases of cancer of the breast reported by J. Mason Warren,[1] there were of scirrhus 54 (one patient a male), and of encephaloid only five.

Paget thinks the proportion, in Great Britain, not greater than 5 of encephaloid to 95 of scirrhus. M. Lebert[2] states that, in France, about one-fifth of the cancers of the breast are soft and encephaloid.

The time of life during which patients may suffer from cancer of the breast is from 28 to 84: the majority of cases occur between 40 and 50. Out of 160 cases observed by Nunn,[3] 36.87 per cent. were between 40 and 50. Birkett gives 193 out of 458 cases between the ages of 40 and 50. In a series of 276 cases observed by Paget, there were patients:—

Between 20 and 30 years of age	5
" 30 " 40 "	41
" 40 " 50 "	122
" 50 " 60 "	65
" 60 " 70 "	35
" 70 " 80 "	8

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[1] Surgical Observations.

[2] Des Maladies Cancéreuses.

[3] Cancer of the Breast.

It will be seen by these statistics, that cancer of the breast is rare before 30. It has been met with at the age of 28 in several instances, and I have myself met with one case of scirrhus at this age. Henry, quoted by Gross, records a case at 21. Mr. Sibley records as the earliest age, 26, and as the latest, 84. I have met with and operated upon 2 patients at 84 years of age; and Mr. Bryant refers to a case of one year's standing in a patient 96 years of age; but the disease is not common after 70. [The Editor saw some years since, with Dr. Albert H. Smith, of Philadelphia, a case of atrophic scirrhus in the breast of a patient aged 89.]

In regard to the effect of marriage, lactation, and other conditions connected with the generative functions, on production of cancer of the breast, it would appear that the disease is more common in the married, and in those having children. Of 160 patients referred to by Nunn, 22 were single, and had no children; 138 were married, of whom 51 were sterile, and 87 had children, having on an average, 5.5 children. Baker[1] gives a table of 260 cases of cancer of the breast, in which there were of:—

Single women	23.0 per cent
Married women	72.4 "
Widows	4.6 "

Gross notes that of 688 women, 607, or 88.22 per cent., were, or had been, married, and 81, or 11.77 per cent. were single. Of 435 women, 365, or 83.91 per cent., had borne children; and of these nearly nine-tenths had had more than one child, while 70, or 16.09 per cent., were barren.

In regard to the influence of menstruation, Paget gives a table of 400 cases as follows:—

Ages.	Cessation of Menstruation.	First observation of the Cancer.
Below 35	9	36
35 to 40	51	62
40 to 45	140	78
45 to 50	159	101
Above 50	41	123

It would serve no practical use, in the present state of our knowledge, to discuss here the *causation* of cancer, but it is enough to consider that the female breast is one of the organs in the body which appears to be favorable for the development of this disease, and that prolonged local irritation or injury, in not a few cases, acts as an excitant of its development. Paget found that out of 91 patients only 16 ascribed the cancer to injury or any such local cause. Dr. Gross states that in 23 out of 270 cases analyzed by Winiwarter and himself, the disease was ascribable to traumatism—such as blows and contusions, and that in 5 of 370 cases collected by Oldekop and himself, it was preceded by eczema or psoriasis of the nipple, while it started from lumps or chronic indurations left by puerperal mastitis in 30, or 8.21 per cent. of the 365 women who had borne children. The association of eczema of the nipple and of the skin around it with the production of cancer of the breast, has been brought under notice by Sir James Paget,[2] Mr. Butlin,[3] Mr. Henry Morris,[4] Dr. Thin,[5] and others. From a consideration of the recorded cases of this condition, it would appear that in some instances there has been a history of from five to six years' local irritation before the development of the cancer, while in other cases the cancer has been developed within two years from the first appearance of the eczema. In one case reported by Mr. Morris, the local irritation amounted to ulceration. In some of the reported cases there has been a distinct portion of healthy tissue between the affected skin and the cancer in the gland, but in others the two conditions have been continuous. These cases have been met with at the ages of 33, 40, and 60 years, and at periods between those ages.[1]

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[1] Med.-Chir. Trans., vol. xlv.

[2] St. Bartholomew's Hospital Reports, vol. x. 1874.

[3] Med.-Chir. Trans., vols. lx. and lxiv. See, also, Vol. IV., page 634, *supra*.

[4] Med.-Chir. Trans., vol. lxiii.

[5] Med.-Chir. Trans., vol. lix.

Hereditary tendency also influences, but not to a great extent, the development of cancer in the breast. According to Nunn, in 160 cases, cancer had been treated among the relations in 47 cases, or 29.3 per cent. Of 389 cases quoted by Gross, 40, or 1 in every 9.72, stated that cancer had occurred in some of their ancestors.

The hereditary history of phthisis has also been thought to influence the occurrence of cancer; Nunn mentions that out of 160 cases, phthisis was traced among relatives in 36. Sibley found 48 instances of the occurrence of phthisis in 130 cases.

Mr. Nunn has pointed out an interesting fact in connection with the longevity of the families of patients suffering from cancer of the breast. In 169 cases observed by him, the average age of the fathers was 62.25, the average of the mothers 61.53; 106 patients had grandparents who had lived to be more than 70 years old; 62 had parents who had lived to be more than 80 years old; 15 had grandparents known to have lived over 90 years.

It has also been observed that the majority of patients are in good health when the cancer first develops itself. Paget found that in 91 cases no less than 66 presented the characters of robust, or at least good, health, 9 were of uncertain or moderately good health, and only 16 were sickly or feeble. Baker also observed that only 5.2 per cent. of patients suffering from scirrhus of the breast were in bad health when the disease was first observed. Gross says that out of 189 patients, in whom the general condition is mentioned, 97, or 51 per cent., were in robust health, 34, or 18 per cent., were in good health, 37, or 19 per cent., were pale and thin, and 21, or 11 per cent., were decidedly broken down from the effects of the disease.

The *progress and duration of cancer of the breast*, if uninterfered with by operation, vary considerably in different cases, and also vary in the two forms of the disease. According to Paget, the average duration of scirrhus is a little more than four years, while in an encephaloid cancer it is rather more than two years. In 61 cases quoted by this surgeon:—

7	died	in between	6	and	12	months.
7	"	"	12	"	18	"
8	"	"	18	"	24	"
10	"	"	24	"	30	"
2	"	"	30	"	36	"
12	"	"	3	"	4	years.
6	"	"	4	"	6	"
3	"	"	6	"	8	"
1	"	"	8	"	10	"
5	"	"	10	"	20	"

Sibley makes the average 32 months, and Baker 43 months.

Cases of cancer of the breast have been known to run a rapid course of a few weeks or months, but, on the other hand, some varieties of scirrhus will exist for several years; cases have been recorded of 10, 15, and 20 years' duration, without the disease progressing.

When the disease occurs during pregnancy or lactation it sometimes runs a very rapid course. I once operated upon a mother and daughter for scirrhus of the breast, both within two weeks; the daughter was nursing when the disease first showed itself, and in her case its progress was much more rapid than in the case of her mother, and further, the disease returned in the daughter's breast much earlier than in the mother's. During the progress of the disease, changes may take place in the tumor itself, and the cancer sooner or later involves the surrounding textures, and affects the lymphatic glands and perhaps the internal organs. The changes which affect the substance of a cancer of the breast are those met with in all cancers, and consist of fatty and granular degeneration of the cells, cystoid degeneration, occasionally calcareous degeneration, inflammation, ulceration, suppuration, sloughing, and fungation. In addition to these, a scirrhous cancer may undergo atrophy, or shrink, as will be more particularly referred to in the consideration of this form of the disease.

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[1] See Plate XXIII., Vol. IV., page 634, *supra*.

In the progress of cancer of the breast, the lymphatic glands in the axilla and cervical region become sooner or later affected, in the majority of cases; the surrounding skin may at any time become affected with cancer, either in the form of nodular deposits, or, more rarely, a flat, hard thickening of its substance. Adhesion, discoloration, thinning, and ulceration or sloughing of this same tissue, are also not uncommon, and less frequently the muscles become infiltrated with cancer, while in rare instances the other breast may become involved. (Plate XXXII.) Certain of the internal organs and structures are liable to become the seat of secondary growths, and among the chief of these are the lungs, liver, and pleura. From an interesting series of 128 post-mortem examinations of cases of cancer of the breast, collected by Gross, we note that the axillary glands were affected in 89.4 per cent.,

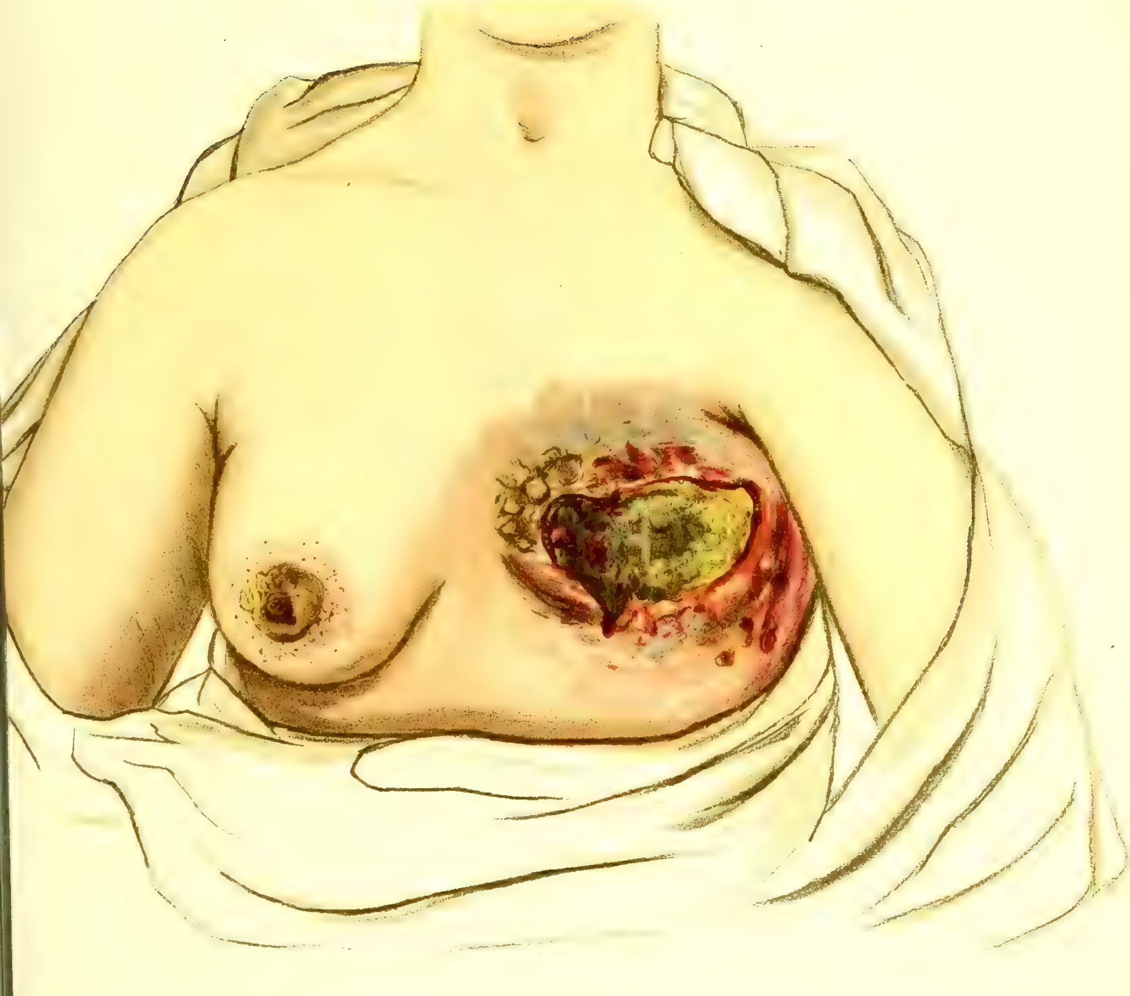
Other glands in	23.43	per cent.
Pleura	23.43	"
Lung	21.87	"
Liver	42.96	"

Nunn also gives a table of 21 post-mortem examinations of cases of cancer of the breast, which likewise shows the frequency with which the liver, lungs, and pleura become involved. More rarely the stomach, ovaries, kidneys, bones, brain, and occasionally other internal organs or tissues, are affected.

The effect of operative interference on the progress of cancer of the breast may be here briefly noticed. Experience proves that operative treatment, when the entire disease can be removed, tends to prolong life, and that even in acute cases of the disease an operation may for a time, although it may be for only a very short time, check its progress. Although therefore the removal of a cancerous breast cannot be considered a very satisfactory proceeding as regards its results in curing the disease, there is sufficient testimony to encourage a resort to the operation in properly selected cases; and most surgeons can, amongst many failures, record instances in which patients have remained free from a return of the disease for five, ten, or more years. It must also be remembered that the removal of a cancerous breast will frequently take away, at least for a time, a painful and weakening complaint, and will do much to relieve the sad mental distress which such a disease produces.

Scirrhous Cancer.—Varieties of this form of cancer have been described under the terms "simple carcinoma," "fibroso-medullary cancer," and "atrophic" or "chronic cancer." These varieties are merely the result of differences in the amount of cells and stroma in the tumor, or of degeneration of the cell-element, with contraction of the stroma in which the cells are imbedded. These variations lead to certain differences in the

PLATE XXXII.



rcinoma of both breasts; ulcerated on the left side; on the right side showing lardaceous appearance of skin.

om a patient in the Hospital of the University of Pennsylvania.)

H. BENCKE, LITH. N.Y.

appearance, consistence, and progress of the growths, but they all possess the general characteristics of cancer.

Symptoms, Diagnosis, and Progress.—In the early stage of the disease, the most common condition is that of a hard, irregular, more or less circumscribed lump in the breast structure; this lump is not usually large, but in some cases of acute disease it may grow rapidly. The situation of the lump varies; it is most common towards the outer border of the breast, not far from the nipple and a little above it, but it also occurs at other points in the gland. There may or may not be adhesion of the skin with a corresponding depression, and the nipple may or may not be drawn down and retracted. Out of 100 cases, Gross found retraction of the nipple in 52. The neighboring lymphatic glands may or may not be affected. The hardness varies in degree according to the relative proportions of cell-element and stroma, but in most instances it is well marked and stony in character. This symptom is best detected by pressing the tumor backwards against the ribs, standing behind the patient while doing this. Occasionally, some part of the tumor may be softer, owing to the presence of cysts. The amount of irregularity also varies; in some instances the swelling is distinctly nodular, while in others it is smoother to the touch. The outline differs in different cases: the growth may feel circumscribed, except at its point of connection with the breast-structure, but in other instances the cancerous material may be infiltrated into the surrounding textures, and the margins of the growth may be consequently ill-defined. The fixedness of a scirrhus depends upon the amount of its infiltration into the breast-structure, and upon the adhesion and involvement of skin, fascia, and muscles. In its early stage, the growth may be freely movable except at the point of its attachment to the gland, but in its progress this mobility may become very limited.

As a rule, a scirrhous growth is not painful to touch, although in a sensitive patient even gentle pressure may be complained of. In many cases the patient suffers from pain shooting through the breast, and this is most common in acute instances of the disease. The whole affected breast usually presents some alteration in appearance, size, and position; and occasionally discharges, tinged with blood, run from the nipple. These are the symptoms most frequently met with in connection with scirrhus of the breast, but there is much difference in regard to the rapidity and nature of its progress. In cases in which the cancer becomes infiltrated into the greater part of the breast-structure, there is general enlargement and induration of the breast, and in well-marked examples of the atrophic form the gland-structure in great part disappears, and the growth and adherent textures resemble a depressed, hard, and contracted cicatrix.[1]

In a few instances (1 in every 48, according to Gross), the disease is met with in the form of distinct nodules. As an assistance to diagnosis, the age of the patient may be considered: reference has already been made to the fact that the largest number of cases occur between the ages of 40 and 50. Constitutional cachexia occurs at varying times after the first appearance of the disease. In a few instances it is present almost from the first, but in the majority it only becomes marked during the progress of the disease.

By means of the symptoms mentioned, scirrhus of the breast can usually be diagnosed, but occasionally other conditions, and more particularly chronic inflammatory induration of the breast-structure or portions of it, and chronic abscesses or cysts with induration of surrounding textures, simulate this form of cancer very closely. Should general and local treatment not speedily relieve these conditions, and the case be of doubtful nature, no time should be lost in making an exploratory, antiseptic incision, so as to determine the true character of the swelling.

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[1] See Plate XXIV., Vol. IV., page 643.

If scirrhus of the breast be not interfered with by operation, it progresses more or less rapidly. In the acute form of the disease its progress may be very quick, and it may run its course and cause death in a few months, more especially when it attacks a patient who is pregnant or nursing at the time. Billroth relates a case in which death took place six weeks after the first appearance of the disease, and in which the liver, kidneys, omentum, pericardium, and thyroid gland contained secondary deposits. This however must be considered an exceptional case. It has also been noted by Paget that, although exceptions occur,

> "On the whole, the earlier the disease begins the quicker is its course. Thus, among those who lived not more than 18 months, I find that the average age at which the disease was first observed was 43 years. Among those who lived between 18 and 36 months, it was 51 years ; and among those who lived between 3 and 8 years, the average at the commencement of the disease was 56.7 years."

These statistics are taken from cases which had not been interfered with by operation.

From six months to fifteen or twenty years may be considered to be the duration of cases of cancer of the breast, but a very large proportion die at some period between six months and three years.

Involvement of Lymphatic Glands.—As has already been mentioned, the time of such involvement varies; one, two, or many glands may become affected in the axilla, and for some time such glands may be movable and circumscribed ; but as the case progresses, more glands become affected, and the result often is a hard, irregular mass in the axilla, pressing upon the veins and nerves, giving rise to œdema of the whole arm, and to pain more or less aggravated. The infection of the glands would appear to take place not directly through the lymphatic vessels themselves, but by means of cells forming in the lymph-spaces of the breast, and then being carried along the radicles of the lymphatic vessels which are continuous with these spaces. The glands having once become involved, act as centres for the spreading of the cancer, for the infection of the blood through the thoracic ducts, and for the implication of internal organs.

Lymphatic glands in the axilla are occasionally enlarged from inflammatory irritation in connection with cancerous disease of the breast, especially if ulceration or sloughing be present. The cancerous gland is hard and firm ; the inflammatory enlargement is not so hard, and is relieved by soothing applications. Less frequently the glands under the clavicle and in the cervical region become affected, and hard cords are sometimes felt passing from the breast to lymphatic glands in both axilla and neck. I have occasionally seen such cords, resembling inflamed lymphatics or veins passing down into the abdominal wall. It may be here noted that the situation of the cancer does not appear to influence glandular affection, and further, that when there is early glandular affection, the disease is more acute and runs its course more rapidly.

Involvement of the Skin, Deeper Textures, and Internal Organs.—The skin may at any time become involved in the disease. At first this may be in the form of an adhesion or infiltration which confines itself to one point, and gradually becomes more marked, or discoloration with thinning of the skin may take place early, and soon be followed by suppuration and ulceration. In one form of the disease, which is not very common, the whole skin and subcutaneous tissue over the breast, become thickened and infiltrated, and this condition may spread and affect the whole skin of the thorax, portions of the abdominal wall, and occasionally the skin over the shoulders, back, and arms, the so-called cancer "*en cuirasse.*" When ulceration takes place, it spreads more or less rapidly, and may be associated with sloughing; so that the tissues may be destroyed by both of these processes. In rare cases the whole diseased mass perishes, the slough or sloughs separate, and the ulcer heals. Associated with ulceration there may be fungation of the growth, but this is much more common in the medullary form of cancer. Occasionally the ulcerated surface of a cancer will heal at one point while the disease is progressing at another. The muscles, fasciæ, and even the neighboring bones, may become involved by infiltration of the cancerous material, and in such cases the breast is usually very adherent to the deeper parts. The disease may so seriously affect the pectoral muscles as to form in them a tumor of considerable size. The pleura and lungs may become involved, either by direct extension of the disease through the lymphatic system, or more rarely through the bloodvessels, or in both of these ways.

The other internal organs, and distant tissues, are most frequently infected through the lymphatic system, but occasionally through the general circulation.

MEDULLARY CANCER.—As has already been mentioned, this form of cancer occurs in the breast in about five per cent. of all cases. It has usually been described as occurring as a rule at an earlier age than scirrhus, but, according to Gross, "it occurs as early as 29 and as late as 69 years, the average being 50. Twenty per cent. of all cases are met with before 40, and eighty per cent. after that age, while exactly one-half occur after 50."

The tendency of this disease is to run its course more quickly than scirrhus, to attain a larger size, to affect the skin earlier, to ulcerate, fungate, and bleed more frequently, and to cause a greater enlargement of the lymphatic glands. According to Gross, local recurrence takes place "within three months after removal, in 81.81 per cent. of all cases. Metastatic growths are always discovered on post-mortem inspection, and are preceded by taint of the glands of the axilla in three-fourths of the instances, and the total duration of life without surgical intervention is only eight months." These growths are usually more or less lobulated; they may be at first firm to the touch, or they may be from the beginning soft and elastic. They become softer as they grow, and often fluctuate at one or more points, owing to the formation of cysts in their substance. They have been known to grow to the size of a child's head in the course of a few weeks or months.

Treatment of Cancer of the Breast.—As no medical or local treatment short of the removal of the entire growth and breast has as yet been discovered for the cure of this disease, the choice of treatment lies between an operation and the employment of some palliative means to relieve the symptoms. The internal administration of various drugs has been tried for the alleviation of cancer: among these are arsenic, iron, and iodine, with their combinations; alkalies, such as ammonia, soda, and potassa; and acids, especially hydrochloric and phosphoric; but although some of these may be useful in improving the condition of the general health, they cannot be said to have any effect upon the disease itself.

Various vegetable infusions have also been lauded in connection with the treatment of cancer, and among these, infusions of the cliver grass (*Galium aparine*) have occasionally been thought to do good. Mr. Cooke[1] advises a fresh infusion made by pouring a pint of boiling water upon two ounces of the stem of the plant, half of this to be taken in twenty-four hours; or a tablespoonful of Squire's expressed juice three times a day. The administration of general sedatives by the mouth or rectum, or by subcutaneous injection, is advisable in cases attended by much suffering which cannot otherwise be relieved. The particular form of sedative, and the manner of its use, must depend upon the special conditions and tolerance of the patient. Local applications of a caustic or irritating nature ought never to be applied, unless with the object of thoroughly and at once destroying the whole diseased mass, and even under these circumstances their use should be confined to cases in which the patients object to the knife. Topical remedies, when used, should be of a soothing nature, and among the best of them are warm water, belladonna, and sugar of lead; the two latter may be used as lotions, or in the form of a plaster, according to the nature of the case. It is important, also, to prevent any undue or irritating pressure upon the tumor, by means of proper arrangement of the dress. In cases where ulceration or sloughing is present, and when the case is not suitable for operation, or the patient declines to have an operation, non-irritating applications should still be the rule. When there is much offensive discharge, the application of a charcoal or elm poultice is often useful in cleansing and soothing the sore.

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[1] On Cancer, its Allies and Counterfeits.

Boracic-acid lotion, boracic ointment, or equal parts of boracic ointment and vaseline, are also good applications; these latter dressings may be covered with layers of salicylic wool, carbolized wool, or antiseptic marine lint. Gross advises as a deodorizer, and also for relieving pain, an ointment consisting of five grains of chloral hydrate to one ounce of cosmoline.

Esmarch uses a powder composed of arsenious acid and muriate of morphia (of each 0.25), calomel 2.0, and powdered gum Arabic 12. Half a teaspoonful of the powder is daily sprinkled on the surface. When bleeding takes place from the ulcerated or sloughing surface, some styptic should be applied if simple cold does not stay the hemorrhage. A piece of lint or cotton-wadding soaked in a solution of alum or tannin, or in the tincture of the muriate of iron, or in a mixture of equal parts of tincture of perchloride of iron and glycerine, should be applied to the bleeding point. In several cases of feeble and old patients suffering from a limited, ulcerating, and offensive cancer of the breast, I have, with the thermo-cautery, freely removed the ulcer and surrounding disease, without attempting to take away the whole breast. Two of these patients were 84 years of age, and in both instances a healthy, granulating sore was the result, and much comfort was given to the patients and their friends. When the arm is swollen and œdematous, it should be supported by means of a comfortable sling, and the application of a cotton-elastic bandage around the whole limb should be tried, and continued if found to be useful. Gentle friction upwards of the whole arm often assists in relieving congestion and promoting the venous circulation.

Operative Treatment.—It has already been said that statistics prove that an operation prolongs life in many instances; and the most recent experience undoubtedly shows that early interference and more complete methods of operating, tend to still further prolong life, and to make this formidable disease less rebellious to treatment. The late Mr. Moore[1] directed attention to the importance of removing not only the breast, but all the surrounding textures and lymphatic glands. Gross is of opinion that even in cases of circumscribed tumors this proceeding should be carried out. Dr. Mitchell Banks, of Liverpool, in an interesting paper on this subject,[2] after remarking that the axillary glands may often be affected without being felt externally, adds that from his experience, "in every case where the breast is removed, the axilla should be cleared out as a necessary accompaniment." Prof. Küster advocates the removal of the axillary glands in all cases. He has operated on 117 cases in this way, and in only two were the glands entirely free from disease when carefully examined. Prof. Gussenbauer also advises the same proceeding, and in addition thinks that the supra-clavicular glands should be removed.

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[1] Med.-Chir. Trans., 1867.

[2] Brit. Med. Journal, December 9, 1882.

In serious glandular involvement, portions of the axillary vessels and nerves have occasionally been excised. Langenbeck has done so in three cases, but in one of these the patient died from gangrene. Esmarch considers that it may be advisable to amputate at the shoulder-joint in such cases.

Experience and facts then prove that a thorough removal of the tumor, together with the breast, surrounding tissues, and axillary glands, will much improve the chance of permanent relief in this disease. Prof. Küster's testimony as to the frequency with which the glands of the axilla are involved, is most valuable in deciding the importance of taking them away at the time of the operation.

It must be observed that a more complete operation adds somewhat to the mortality; but with careful antiseptic precautions, such mortality is not likely to be large.

An early and thorough operation, including the removal of the glands in the axilla, is therefore advised in all cases of cancer of the breast in which it is possible to remove the entire seat of disease, and in which the patient's general condition admits of such an operation. If a patient objects to the knife, the operation may be performed with the thermo-cautery; and, if circumscribed, the disease may be destroyed by some strong caustic, such as chloride of zinc, in the form either of a paste or of Maisonneuve's arrows. I prefer the method employed by the late Mr. Syme, which consists in applying a paste of strong sulphuric acid and lampblack, the surrounding parts being protected by a wall of gutta-percha, attached to the skin by means of a solution of gutta-percha in chloroform.

Operations in recurring Cancer.—The principle to be followed in these cases is that now usually acknowledged among surgeons, namely, to remove the growth and surrounding parts as soon as the disease recurs, and to repeat the operation as often as may be necessary, provided that the disease remains local and can be removed, and that the patient's health admits of it. I have repeatedly operated on this principle, two, three, four, or more times, and have, in this way, prolonged patients' lives; and most practical surgeons have had like experience.

Method of Operating.—No strict rule as to special incisions can be laid down in connection with removal of the breast for cancer. The nipple and skin around it should always be taken away, and when the skin is at any point adherent to the breast or tumor, or is affected with the disease, it should be freely removed. The incisions should be made in such a direction and to such an extent as thoroughly to expose the whole breast and the tissues around it, to take away the nipple and areola, with any adherent or affected skin, and to expose the axillary space. Another point, but it must be considered a minor one, is to make the incisions so that the edges of the wound may be approximated without tension, and with least risk of their separation by muscular action. When the whole breast and the surrounding textures have been thoroughly exposed (and in dissecting off the skin and areolar tissue care must be taken not to separate along with them portions of breast-structure), the mass should be removed, together with the fascia on which it rests, and then all tissues—fatty, fibrous, or muscular—which show any signs of involvement should be taken away, and the axilla carefully searched and all glands removed. If there is any difficulty in getting access to the axillary glands, one or both pectoral muscles may be divided; but this proceeding is not often required.

In removing glands from the axilla, it is important to ligature any vessels that are met with before dividing them, as there may be difficulty afterwards in securing them, more especially if they are divided close to the main trunks. In cases where the edges of the wound cannot be brought together, I have sometimes found it useful to stitch the skin of the flaps to the muscles below, so as to prevent its inversion and retraction. It need scarcely be said that the whole operation should be conducted on strictly antiseptic principles.

Affections of the Male Breast.

Hypertrophy.—The male breast has occasionally been met with largely hypertrophied, and if such a condition should be troublesome, removal of the gland would be the best proceeding, if the patient's health admitted of an operation.

Inflammatory Affections.—The male breast may be affected with inflammation, and occasionally an abscess results. An enlarged and tender condition of one or both glands occurs sometimes in young men. The elder Gross refers to three cases in his work on Surgery, and I have met with two cases affecting the left breast. In one of these the condition returned several times, leaving the breast somewhat enlarged.

The *treatment* of these conditions must be soothing, locally, with avoidance of any injurious pressure from the clothes, and the administration of saline aperients, followed by tonic remedies if the health is not good.

Tumors.—Both simple and malignant growths are occasionally met with in the male breast. Among the former are cysts (in one recorded instance the cyst contained milk) and fibromas. Among the latter are spindle-celled sarcomas, of which I have seen two examples, and cancers, which are most frequently of the scirrhous variety. The simple, infiltrated, atrophic, and cuirass-like form have all been observed in the male breast. About two per cent. of all cases of mammary cancer occur in the male breast, and the disease runs its progress more or less rapidly, and involves other tissues and organs, as in women.

The *treatment* of the various tumors which affect the male breast is that of similar tumors as they occur in the female.

INJURIES AND DISEASES OF THE ABDOMEN.

BY

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CONTUSIONS OF THE ABDOMINAL PARIETES.

CONTUSIONS of the abdominal parietes may or may not be associated with injury to some of the abdominal contents. If the viscera be involved, the seriousness of the injury depends upon the damage within the abdomen; if not involved, the severity of the case varies with the area and depth to which the parietes are contused, and more especially with the depth. Thus, contusion of the skin and muscles is more serious than contusion of the skin alone, and if the peritoneum partakes in the injury, the gravity is greatly increased. Where a severe abrasion or an actual wound exists, or a large bloodvessel or muscle has been subcutaneously ruptured, or the tissues disorganized by pulping, the risks of the contusion are increased by the complication. Contusions of the parietes may be grouped into (1) Simple contusion or bruise; (2) Contusion with extravasation of blood; (3) Contusion with ruptured muscle; (4) Contusion with pulping or actual disorganization of tissue; and (5) Contusion followed by inflammation and suppuration.

SIMPLE CONTUSION OR BRUISE.—The *symptoms* are ecchymosis, tenderness, pain, swelling, and shock. *Ecchymosis* does not invariably follow a severe blow, and, on the other hand, a slight blow may give rise to wide-spread and extensive discoloration of the skin. Ecchymosis, by which is meant rupture of the capillary vessels of the skin and subcutaneous tissue, and the external discoloration which results therefrom, must not be mistaken for extravasation of blood amongst the deeper structures. Thus, there may be considerable hemorrhage amongst the muscles, or in the subperitoneal tissue, and yet no ecchymosis. When the extravasation occurs from the capillaries of the subcutaneous tissue rather than of the skin, ecchymosis may be delayed until after an interval of three or four days. The ecchymosis may extend uniformly over a considerable surface, or may occur as a number of petechiæ thickly placed, as was well seen in a boy under my care, whose chest and abdomen had been squeezed against a wall by the backing of a wagon; his face, in the course of twenty-four hours, became thickly covered with minute ecchymoses, until it presented a dusky-red color throughout; his abdomen, chest, and other parts were similarly but to a less degree affected. In the course of several days he regained his proper appearance and recovered. Persons with much subcutaneous fat, or with a purpuric state of blood, and those with a strong tendency to hemorrhage from trivial causes, and characteristically styled "bleeders," show most discoloration after simple contusion. The degree of ecchymosis depends, too, upon the region of the abdomen contused; thus, in the umbilical and epigastric regions it occurs more readily than in the lumbar.

Tenderness over the seat of injury is probably the most constant symptom, and it may exist without any other sign. It may be very slight, or very extreme in degree. When experienced immediately or very shortly after the injury, it does not indicate internal mischief; but when coming on only after many hours, or a day or two, it points to the onset of peritonitis.

Swelling depends on the amount of blood, or bloody serum, which is effused, and upon the texture of the region contused. In the loose tissue of the loin it is sometimes very considerable. There is nearly always some slight degree of tumefaction after a blow, even too gentle to rupture the cutaneous capillaries; in these cases there is no ecchymosis, but the part struck is tender and painful, becomes slightly tumefied, then turns red, and in twelve or twenty hours presents no trace of having been hurt.

Pain either is caused by the contusion or actual laceration of the nerves, or is due to pressure of the effused fluid upon them. It is not often severe in uncomplicated contusions, as long as rest is observed, and the abdominal walls are not disturbed by coughing or vomiting; such, or indeed any movements, aggravate the pain.

Shock, in simple contusions, is an uncertain symptom both as to frequency and degree. Sometimes there is none at all; for the suspension of the functions of the part injured, as evinced by the benumbing of the surface, and the temporary suspension of muscular action, are merely the direct local effects of the blow. In other instances the shock is sufficient to kill outright. Pollock and Bryant consider the evidence of the truth of the old doctrine—of sudden death caused by a blow on the abdomen, without visible intra-abdominal lesion—to be unsatisfactory. Le Gros Clark, without denying its occurrence, says that he has never seen a case; and Holmes remarks that, if the doctrine be true, the event is unquestionably rare. Sir A. Cooper, however, quotes the case of a man who was struck on the epigastrium and fell dead on the spot; and Dr. Hunter McGuire, in the second volume of this Encyclopædia, states that he saw a man, struck on the buckle of his sword-belt by a minié ball, fall dead in a few minutes, a contusion of the abdominal parietes being the only post-mortem evidence of injury. This case seems to carry conviction with it of the truth of the old doctrine.

Vomiting is an occasional and early symptom, especially if the injury happen shortly after taking food.

It should be borne in mind that a contusion of the abdominal parietes may be followed by no immediate symptom, and yet that, after seven or eight days, uncomplicated traumatic peritonitis may set in; just as a blow or fall on the head may cause no appreciable symptom at the time, though coma or delirium may supervene after a week or two.

The *causes* of contusion are either direct blows, kicks, falls, violent pinching force, the rough pressure of a nurse's hand, or the forcible compression between two opposing bodies, as in many railway accidents.

Diagnosis and Prognosis.—It is sometimes impossible to say, for a time, whether an injury is simply a contusion of the abdominal parietes, or whether the abdominal contents are injured as well. Neither the degree of shock, nor the kind and amount of pain, nor the presence or absence of tenderness or ecchymosis, enables us to form an immediate diagnosis. Time, and close attention to the development of symptoms—to the character of the vomit, if any; inspection of what passes per rectum; and an examination of the urine—will alone suffice. If, however, extreme collapse, with pallor, rapidly or steadily increasing, follow directly after the injury, it will almost certainly point to laceration of, attended with hemorrhage amongst or beneath, the muscles; or to rupture of one of the abdominal organs. Results alone determine what injuries are superficial and what are associated with grave internal lesions, and every abdominal injury should be treated as if it were serious, until its true nature has been developed by time. Hospital records are suggestive of the probabilities of diagnosis and prognosis, and give an idea of the average risks in contusions of the abdomen. Speaking roughly, it is found that about three-fifths of the patients recover without more than slight and passing symptoms; in considerably less than one-fifth of the cases, symptoms of peritonitis will set in; and in considerably more than one-fifth, rupture of the viscera complicates the contusion, or occurs without any apparent injury of the parietes.

Treatment.—There is no injury of the abdomen, as there is none of the head, which ought not to receive immediate and careful attention. Early precautions may prevent future serious consequences; and even if time shows the results to be slight, the rest and quiet will have conduced to the avoidance of mishap. In all cases, then, after contusion—whether the symptoms be grave or slight—rest in bed, and muscular relaxation, by elevating the head and shoulders and flexing the thighs on the abdomen, must be insisted on for a few days; and if pain be felt, warm fomentations should be applied to the belly. Collapse must be met by warmth to the extremities and to the spine; and, if requisite, by the administration of ammonia or other stimulant. If a blood-tumor exist, it may be tapped with the aspirator; or cold, and pressure by means of strips of adhesive plaster, may suffice to reduce it. If peritonitis supervene, opium should be given, to an adult, in doses of a grain every four or six hours; warm fomentations should be constantly applied; and twenty or thirty leeches should draw blood from the surface of the affected part. In young subjects, the same remedies, but in milder measure, are required.

Contusions complicated by extravasation of blood may involve the rupture of either of two important sets of vessels: the superficial and the deep. Rupture of the *superficial vessels*, more especially of the superficial epigastric, may give rise to such considerable extravasation that the skin of the iliac, hypogastric, and umbilical regions, may be of a black color. The blood may pass downwards to the scrotum and thighs, or, owing to rupture of the deep fascia, the extravasation may go on beneath it, and the discoloration will then extend beyond Poupart's ligament, to which the deep fascia is attached. After rupture of the *deep vessels*, the extravasation will occur beneath the muscles, and between them and the peritoneum, or it may be into the sheath of the rectus. When into the sheath of the rectus, the swelling will be quite circumscribed. When beneath the muscles in the iliac and hypogastric regions, the effusion is in the cellular tissue over the external surface of the peritoneum, above, on each side of, and below, the pubis. Hennen[1] records a fatal case of this sort in a man aged 60 years, who was run over by a carriage. The enforcement of absolute rest, with the constant application of cold, or of evaporating lotions, is the proper treatment in these cases; rarely will the aspirator be necessary, but if the effusion be great and the absorbent powers small, it should be used. Should there be signs of continuing hemorrhage, and if the source of the bleeding is known or can be shrewdly guessed at, an exploratory incision may allow of the ruptured vessel being ligatured above and below the rent. It must be acknowledged, however, that cases of the kind are very rare, and, for the most part, have been recognized only on post-mortem examination. There are no symptoms upon which absolute reliance can be placed; even fainting to syncope cannot do more than lead us to suspect the persistence of bleeding, and this symptom is frequently an attendant upon intra-abdominal injuries in which an exploratory incision would be of no avail.

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[1] Principles of Military Surgery, p. 102.

Rupture of some of the abdominal muscles may complicate contusion. The rectus is more prone to rupture than the flat muscles of the abdominal walls. This accident may occur from direct or indirect violence: a violent and abrupt blow upon a healthy muscle in a state of extreme tension, or a slight blow upon a muscle enfeebled by typhoid or other fever, or any debilitating illness, may cause it; so, also, may some violent, voluntary muscular effort, made to escape the force of some contusing body. As soon as the fibres are ruptured they retract, leaving a gap or interspace which is soon filled up with blood. After a varying period this blood becomes absorbed, and the gap becomes again apparent. If adhesive inflammation does not repair the breach, the parietes are here permanently weakened, and a ventral hernia will in all probability result. Guthrie was of opinion that a severe blow on the abdomen might lead to absorption of the muscle at the spot injured, and this in turn conduce to hernia, without any actual rupture of the muscular fibres; and he has given cases which he believed to support this view. It is possible, however, that in these and other cases actual rupture did really occur, but was not detected owing to the rapid effusion of blood into the rent in the muscle. I might refer in detail to cases of ruptured rectus associated (1) with contusion of the parietes alone, and (2) with contusion of the parietes and rupture of abdominal viscera, but this is unnecessary for the sake of illustration. Ruptures of abdominal muscles, especially of the rectus, during slight or moderate muscular effort in fevers, and in the violent contractions of delirium, have also been observed. Other cases of ruptured abdominal muscle occur from contusion without any lesion of the integuments, but with laceration, detachment, or contusion of the peritoneum. The treatment in all such cases is the same: namely, to relax the muscles so as to approximate the separated edges, and to maintain them in contact, if possible, during repair. Should a ventral hernia occur, a well-adjusted, flat or slightly concave truss, well padded, and retained by means of a suitable belt and buckle, with brace-straps if necessary, should be worn.

Contusion with Pulpefaction of Injured Parts.—Contusion may be so excessive that entire pulping or disorganization of the contused parts may occur, and gangrene be the absolute result. In this complication repair can only take place after the destroyed tissues have been cast off by the process of sloughing. If the injury be superficial, and if the process involve only the skin, a superficial, cellular-tissue cicatrization will soon commence; but if the disorganized tissues be deep, and the skin but little or not at all affected, inflammation and suppuration occur, loosening the gangrenous parts and also attacking the overlying structures, until abscesses are opened and sloughs removed through the incisions made. The abdominal walls are left weak; and hernial protrusions follow the tardy completion of the healing process. The treatment of this complication is the same as that required for the separation of gangrenous tissues in other parts of the body: the strength of the patient must be kept up, opium must be given to allay pain and irritability, the appetite must be improved by the use of quinine or ammonia and bark, and warm fomentations and antiseptic applications must be liberally supplied to the parts involved.

Inflammation by no means seldom follows contusions of the abdomen, and it may be either superficial or deep, according to the position of the contused tissues; or it may extend from one stratum to another of the abdominal walls. It is attended with all the common phenomena of inflammation in similar tissues in other parts of the body.

Suppuration and Abscess of Abdominal Parietes.—*Causes*—Either diffused suppuration or abscess may result from a blow or fall, or from forcible pressure upon the abdomen or loin, and they are among the complications or consequences of contusion. Or they may arise from strains of the abdominal muscles. Extravasation of blood, however produced, may give rise to suppuration, owing to the non-absorption or breaking down of the coagula. Extravasation of urine leads to diffuse suppuration and sloughing, always serious, and sometimes fatal; I have seen it spread in the course of a day or two over the whole of the lower two-thirds of the abdomen, and reach far back into each loin. The bursting of an empyema, or of an hepatic abscess, may lead to long and tortuous suppurating tracks in the abdominal walls. Disease of the vertebræ, of the lower end of the sternum, of the ribs and costal cartilages, or of the bones of the pelvis, is frequently the cause of suppuration in the abdominal parietes. In any part of the walls, but especially in the groins and loins, suppuration may extend from the viscera within the cavity of the abdomen or pelvis: thus an abscess which had its starting point in the pelvis, between the uterus and bladder, spread along beneath the peritoneum, across the psoas muscle, until it reached and was detected in the loin.

But abscesses in the abdominal wall may not be traceable to any definite cause; and they are prone to arise from very trivial causes, here as elsewhere, in scrofulous, anæmic, feeble, syphilitic, or otherwise cachectic subjects. They are prone to occur after fever.[1] They are of course met with in pyæmia and in cellular and cellulo-cutaneous erysipelas, both in the circumscribed and diffused forms. Diffused abscesses are generally deep-seated, and occur amid the loose cellular tissue under the tendinous and muscular expansions; here fluctuation and pointing are not often met with, as the tissues intervening between the abscess and the integument resist the pressure of the pus, and are but little, or not at all, susceptible to ulceration. Superficial, diffuse suppuration is only to be met with as a consequence of erysipelas, or where there is great want of power, and therefore but little or no tendency to the adhesive form of inflammation.

Circumscribed abscesses of the abdominal parietes may occur (1) superficial to the muscles, (2) on the deep surface of the muscles, (3) between the muscles, and (4) within the sheaths of the muscles. In the *front* of the abdomen they are rare between the muscles, their usual situation being either subcutaneous, or within the sheath of the rectus, or between the transversalis and peritoneum. Occasionally they arise in the loose cellular tissue about the xiphoid cartilage.

In the *lateral and posterior regions* intermuscular abscesses are less rare, and subcutaneous collections of pus are by no means uncommon in the loins. When an abscess forms on the superficial aspect of the middle layer of the transversalis aponeurosis, whether it be within the sheath of the serratus posticus, of the latissimus dorsi, or of the erector spinæ, the tendency is for the matter to come towards the surface, and then, unless evacuated, to descend subcutaneously to the back of the sacrum, or on to the gluteal or femoral regions. On the other hand, if the abscess forms on the deep aspect of the middle layer of the transversalis aponeurosis, as for example within the sheath of the quadratus lumborum, its tendency is towards the cavity of the abdomen, which it will penetrate unless opened in good time by the surgeon.

An abscess which has commenced in the areolar tissue about the *cæcum*, may open on the front of the abdomen in the right iliac region; one which has commenced near the *sigmoid flexure* may open in the left iliac region; and one which has begun in the cellular tissue around the *kidney* or *colon* may burst into the bowel, the lung, the pelvis of the kidney, or the peritoneum, if it be not opened through the loin.

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[1] A case of abscess in the rectus abdominis muscle after enteric fever, is registered in the Transactions of the Pathological Society of London, vol. xvi. p. 275.

Owing to the firm connection of the subcutaneous areolar tissue to the spinous processes of the vertebræ, it is seldom that pus burrows across from one side to the other of the median line in the back. Abscesses in the epigastric region have a tendency to spread, but rarely penetrate the peritoneum, on account of the strong tendinous aponeurosis which prevents them from doing so. In the umbilical region, if in front of the rectus but within its sheath, the intersections of the muscle and their connections with the sheath prevent pus from spreading upwards or downwards; but when behind the rectus, though within the sheath, it can spread upwards or downwards to a great extent; when outside the sheath and on its deep aspect, it can diffuse itself in all directions; and if beneath the fascia transversalis, it may burst into the peritoneum. In the hypogastrium, subcutaneous abscesses remain for a long time circumscribed, but after a time become diffused if left unopened. Deep abscesses in this situation are dangerous in their consequences, and slow in their course, as a rule. In the iliac regions, besides those already alluded to, abscesses the result of pelvic cellulitis are prone to open. The superficial abscesses in these situations simulate buboes, and are often wrongfully attributed to venereal causes.

Symptoms.—Though the symptoms are, as a rule, acute, and such as characterize acute abscess in other parts, they are sometimes insidious in their onset, slow in their progress, and but little marked even for several weeks. In the *acute* form the onset is sudden, with vomiting, severe local pain, rigors preceding febrile action, full pulse, flushed countenance, thickly-coated tongue, severe headache, and perhaps the general symptoms of fever.[1] For a few days these symptoms may be accompanied by delirium, and the local pain increases, without, however, any *general* abdominal hardness or tenderness; at length the seat of the abscess becomes more evident by redness and œdema of the skin, brawny hardness, and acute tenderness, and within a few days more an obscure softness, but no distinct fluctuation, will be detected. A free incision will now let out several ounces of laudable pus, and from this time all the symptoms will subside, and the patient rapidly recover. If the abscess be deeply seated, the pain may be very widely diffused over the abdomen, and the case for a time is likely to be mistaken for one of acute peritonitis; and it must never be forgotten that these abscesses are liable to set up peritonitis, and even to burst into the peritoneal cavity. When due to an injury, such as a strain or blow, the symptoms may set in at once, or not until several days or even a fortnight afterwards, when violent pain in the part, accompanied by all the severe, constitutional symptoms of acute abscess, appear suddenly. These features were well exemplified in the case of a healthy girl, aged fifteen, who fell from a ladder, striking the right side of the abdomen; this caused her pain for a day or two, but she thought no more of it until a fortnight later, when she became acutely ill; peritonitis after a while supervened, and death from hectic occurred at the end of seven weeks from the date of the injury. A post-mortem examination revealed a large abscess on the right side of the abdomen, between the external and internal oblique muscles, about three inches in diameter; pus had diffused itself through two holes in the internal oblique and transversalis muscles, outside the peritoneum, under the right false ribs; here it had penetrated the peritoneum, and had formed two ulcerated holes in the liver; circumscribed pus was also found on the lesser omentum.[2]

In the *chronic* form, if the effused inflammatory products are deeply seated and firmly bound down, they may give the sensation of a hard, rounded tumor. The pain in these cases often takes the course of some one of the abdominal nerves, and may be quite superficial, and of a constant, fixed, aching character, rather than severe. The patient will probably continue to go about his business, the febrile and constitutional disturbance will be slight, the cutaneous and subcutaneous tissues will be unaffected, and the introduction of a grooved or aspiratory needle, even three or four weeks after the detection of the "lump," may not be followed by the escape of anything but a drop or two of blood. By degrees, however, the pain becomes more severe as the softening of the inflammatory products progresses, and an obscure sense of deep fluctuation may be felt; an exploratory incision will now reveal the existence of pus, perhaps of a very fetid odor from proximity to the bowel. Immediate relief will follow the evacuation of the pus, and convalescence, as a rule, becomes quite established; but in some cases an exhaustive discharge continues, the appetite fails, the strength completely gives way, bed-sores form, hectic supervenes, and the patient dies at some period from a few weeks to a few months from the onset.

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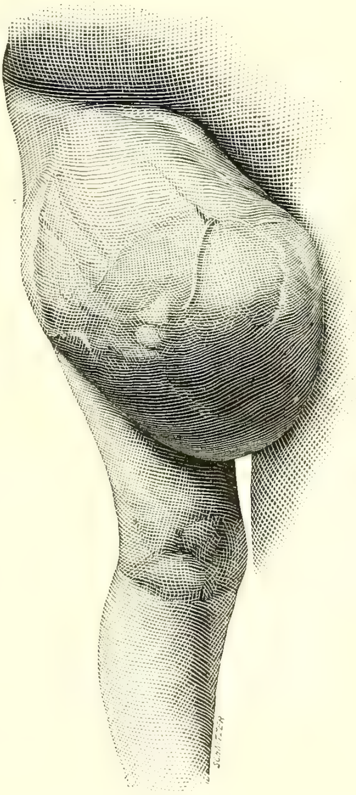
[1] See Lancet, vol. xi. p. 367; case under care of Sir William Lawrence.

[2] Edinburgh Medical and Surgical Journal, vol. ii. p. 129.

Deep-seated abscesses, whether idiopathic or the result of contusion or wound of the abdominal walls, are liable to be followed in the course of time by hernial protrusion at the seat affected. The accompanying wood-cut (Fig. 1113) shows a hernial tumor following an ilio-psoas abscess, which had burrowed up and opened at the inguinal region. Nearly the whole of the hollow viscera were contained in the hernia, and reduction of any part of it some years after its first formation was quite impossible. In another case, that of a retired soldier, a large, flat, tympanitic, doughy swelling in the epigastric and right hypochondriac regions followed an abscess, the result of a wound of the abdominal wall. In this case the hernia, though large, was not pendulous, and could be retained within the abdomen by a well-fitting belt.

Fig. 1113.



Irreducible, ilio-inguinal hernia, following ilio-psoas abscess in a woman. Bands of firm, fibrous adhesions could be clearly seen and plainly felt through the very thin and overstretched integuments.

Diagnosis.—It is often difficult, indeed impossible, to diagnose abscess of the abdominal parietes in its early stage. This arises in part from the fact that, in every region of the abdomen, inflammation and suppuration of the walls are apt to simulate the same affections of the subjacent viscera. It is therefore necessary to bear in mind the normal position of the abdominal viscera, and to have a knowledge of the various sorts of swellings which occur in the several regions. Thus, in the hypochondria, parietal abscess may simulate hydatid or abscess of the liver, enlarged gall-bladder, diseased spleen, a circumscribed collection of pus beneath the diaphragm, or empyema. A further difficulty exists if the parietal abscess is combined with jaundice. In the umbilical region, strumous disease of the mesentery, malignant affections of the stomach, pancreas, and peritoneum, and fecal accumulations in the transverse colon; in the loins, affections of the kidney, colon, and spine; in the iliac regions, disease of the cæcum or sigmoid flexure, of the kidney, or of the pelvic organs, and enlarged lymphatic glands; and in the hypogastrium, pelvic cellulitis, and ovarian and uterine disease, have been known to simulate or be simulated by parietal abscess. Difficulty of diagnosis may arise, too, from an abscess forming whilst a patient is undergoing treatment for some other ailment. I was once greatly concerned about a brawny, tender swelling, accompanied with much constitutional irritation, which formed in the hypogastric region of a very stout young Dutchman, upon whom several days before I had used Holt's dilator for urethral stricture. There was no trouble about the bladder or urethra, and no sign whatever of extravasation, but the inflammatory condition of the abdominal parietes was enough for a time to cause some alarm. After several days an abscess pointed and was evacuated, and the patient made a rapid recovery ; the suppuration was entirely superficial to the muscles, and in the loose, thick, subcutaneous fatty tissue.

Fibrous, fibro-cellular, and malignant tumors have been mistaken for chronic or subacute abscesses; and "phantom tumors" may also lead to error. These "tumors" are due to tonic contractions of portions of muscles, and may occur in almost any part of the abdominal walls. Most frequently they are found in the course of the rectus, but sometimes in the transversalis, one of the oblique muscles, or the quadratus lumborum. They are more or less circumscribed and hard, and can be recognized by their being fairly resonant, not painful or tender on pressure, and by generally disappearing under continued manipulation, and during the withdrawal of the patient's attention.

It will be only after a careful investigation of the symptoms and clinical history, and repeated examination of the indurated or tender area of the abdominal walls, that a correct opinion can be arrived at in a large number of cases. Assistance in some instances will be gained by a rectal or vaginal exploration, and the excretions from the bowels and kidneys should always be examined. Sometimes an exploratory incision or puncture will be required to make the diagnosis quite clear. When the abscess, or inflammatory deposit which precedes abscess, is chronic, it constitutes one of the many causes of the "fixed abdominal pain," and then has to be distinguished specially from inflammatory adhesions within the abdomen, and from the dragging of displaced omentum, colon, or sigmoid flexure.

Treatment.—This is the same as for local inflammation and abscess in other parts of the body. Rest, the use of warmth and fomentations, the application of from 12 to 20 leeches, and the administration of cooling salines, will subdue the intensity of inflammatory action ; and anodynes will be required to allay pain. As soon as the presence of matter is suspected, an exploratory puncture should be made, and the sooner the abscess is freely evacuated the better.

There is danger in leaving deep abscesses unopened, as they are liable to set up peritonitis and terminate in fecal fistula; nerves, too, may be dissected out and lie bare in the cavity, and bloodvessels may be ulcerated into. The iliac veins have been thus laid open by abscesses spreading from the loins ; the kidney has become disorganized, and the vena cava obliterated, by the pressure of an unrelieved abscess commencing within the sheath of the quadratus, or in the peri-renal fatty and areolar tissue.

After opening the abscess, nutritious diet, and stimulants and tonics, are needed to keep up or improve the patient's strength. As the organs nearest the affected parietes are apt to become involved, such complications as jaundice, pneumonia, flatulent distension of the bowels, or constipation with pain, from delay in the passage of the intestinal contents, must be treated as they arise. Sympathetic vomiting is often a very troublesome symptom in the onset of the local inflammation, no matter in what part of the abdominal parietes it occurs; a subcutaneous injection of morphia sometimes acts like a charm in checking this, besides having the additional effect of alleviating pain.

BURNS AND SCALDS OF THE ABDOMINAL PARIETES.

Burns and scalds of the abdominal parietes are of a highly dangerous character, but in civil life are seldom limited to this part of the body, being, as a rule, associated with burns or scalds of the thorax, back, or nates and thighs. In military life they are the result of explosions, or the bursting of fire-arms, cartridge-boxes, shells, etc., and are, therefore, frequently accompanied by lacerated and contused wounds of more consequence than the burns. On board ship, very terrible cases, from time to time, occur from the bursting of engine, boilers, etc. The usual classification of burns and scalds applies to those which affect the abdominal walls, and need not be further referred to here. Velpeau has compared burns with contusions from balls and shot; and considers it impossible to distinguish them from one another, or to say how the eschar has been caused; there is in each case sphacelus of the injured parts and reddening of the skin around, whilst the processes of separation of the slough and repair of the wound are the same in both. The constitutional symptoms, prognosis, post-mortem appearances, and treatment, do not differ from those of burns and scalds of other parts of the body. There is no greater tendency to effusion into the serous cavities of the brain, chest, or abdomen; nor to muco-enteritis, or ulceration of the duodenum or other parts of the intestines, than in burns of corresponding degrees in other regions; though if the destruction of tissues is deep and extensive, there is danger of peritonitis from extension during the inflammatory stage. I have, during this stage of burns involving the abdominal wall, several times found great and widespread pain of the abdomen complained of; and when this has been accompanied with vomiting or diarrhœa, as is sometimes the case, the prognosis has for a few days seemed doubtful, because of the uncertainty as to how far the mucous coat of the stomach or bowel has become involved. The cause of death, when ulceration occurs, is, generally, either hemorrhage from the bowel, or peritonitis from perforation. Holmes[1] gives an illustration of a case in which the pancreatico-duodenal artery was laid open by an ulcer of this kind. Ulceration of the intestine after burns is not, however, necessarily fatal.

That extensive burns in every part of the body may be followed by ulcer of the duodenum, there is no doubt. Holmes states that in 16 cases out of 125, of intense burn, ulceration of the duodenum occurred, and ulcers in other parts of the intestines in two cases. Stokes found ulcers of the duodenum and stomach in one case of severe burn. Mayer says that ulceration occurs from 7 to 14 days after the injury, and is twice as frequent in females as in males. Holmes puts the earliest date at four days, and says that usually it is after a fortnight. Choostels states that, in eight cases, the shortest time within which ulceration of the bowel was noticed was 2 days, and the longest 17 days after the burn.[1] It should be mentioned that many other conditions are known to have been accompanied by ulcers of the stomach or duodenum, or both; such as erysipelas, pemphigus, and pellagra. Foreign bodies in the gastro-intestinal tube may of course give rise to ulceration.[2]

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[1] Principles and Practice of Surgery, 3d ed., p. 107.

CUTANEOUS ERUPTIONS, CARBUNCLE, FURUNCLE, AND ULCERATION OF THE ABDOMINAL PARIETES.

CUTANEOUS ERUPTIONS.—*Rupia*, *ecthyma*, and most of the cutaneous eruptions, syphilitic and simple, affect the surface of the abdomen, but need not here be considered. The first evidence of secondary *syphilis* is in a large number of cases to be detected in the cutaneous rash on the abdomen; in my experience it is earliest and best seen on the front and sides of the belly.

Herpes zoster not unfrequently affects the abdomen, and may be preceded for some days by severe pain, the cause of which will seem quite inexplicable. If the eruption is coming out low down, upon the surface supplied by the ilio-hypogastric and ilio-inguinal nerves, the testicle may be the seat of pain, and through the irritation of the genito-crural nerve may be drawn up towards the external ring, and a renal calculus may be suspected. The absence of functional disturbance of the abdominal viscera, and the appearance of a crop of vesicles along the course of the nerves, will, however, soon make clear the nature of the case.

BOILS AND CARBUNCLES occur on all parts of the abdomen and in the lumbar regions, and are by no means uncommon, though less frequent here than on the neck and on the nates. I have had to treat some very severe cases of carbuncle both in the hypogastric and lumbar regions, and have had the happiest results, here as in other parts of the body, by wiping over the surface and edges with liquid carbolic acid, lightly applied by means of a small wad of cotton-wool, and boring three or four holes into the swelling with crystals of the acid pressed upon the surface; as soon as the acid has penetrated the skin, it permeates the diseased structures and its action becomes widely diffused. Sometimes, three or four days are required before a free opening is effected; but I have always found the spreading of the carbuncle to be checked by the first application, and am so impressed with its beneficial effects that I take this opportunity of recommending it to those who have not tried it.

ULCERATION of the surface of the abdomen occurs as the result of neglected, irritated, or badly treated scratches or abrasions of the skin, and of the excoriations about the umbilicus and in the groins of persons of dirty habits and unhealthy constitution. The umbilicus in new-born babes, and in very fat adults, occasionally becomes inflamed and ulcerated from neglect of cleanliness. In the former, after the separation of the stump of the funis, profuse suppuration, or serious ulceration, attended sometimes by fatal hemorrhage, occurs instead of healthy cicatrization: I have seen ulceration from this cause followed by fatal erysipelas of the parts around the umbilicus.

Treatment.—If the ulceration is slight, cleanliness, and the application of lead lotion or benzoated-zinc ointment, will suffice; if it becomes indolent, some stimulating lotion or ointment will be required. If there is much inflammation, or hemorrhage, prompt and decisive treatment to check the one or the other must be adopted, since the inflammation is prone to spread, and the bleeding to recur, and since either condition may end in death in the course of a few days.

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[1] Am. Journal Med. Sciences, October, 1883.

[2] See section on Foreign Bodies in Stomach and Intestines.

I have also known ulceration to arise from a simple *pimple*. This occurred in the person of a stoutly built and apparently healthy woman aged 48, who for some time had had a small, hard pimple situated about two inches above Poupart's ligament; it at length became red and irritable, and in the course of six days enlarged to the size of a walnut; within another four or five days it was a large, ovoid ulcer, 12 inches by 7, with thickened edges, and a profuse, offensive, purulent discharge from its base. During cicatrization a great deal of superficial pain was felt, extending from the back to the groin, which was relieved by the application of belladonna ointment to the edges of the ulcer. The healing was very slow, and took nearly four months for its completion, the patient nearly the whole time, after being first seen, keeping her couch. The origin of the ulcer appeared to be quite local, and due to the chafing and neglect of a simple pustule; there was no syphilitic taint, and there were no enlarged glands, nor sores in other parts of the body. Iodide of potassium and mercury had no effect upon the ulcer, which however healed under the application of vaseline, and then carbolic-oil dressing (1 in 40), and the internal administration of quinine and iron.

It is possible that an ulcer such as the above may have a *venereal origin* without being of a syphilitic nature. If an inflamed follicle or an abraded pimple, in the hypogastric or iliac region, or elsewhere, is inoculated by the discharge derived from an impure connection, it is very likely to assume a spreading, chancroidal character. I have witnessed an ulcer of this kind, above the pubes of a man, gradually eat its way into a circular sore the size of the palm of the hand, with raised edges and an irregular, ashy-gray base. It was cured in the course of a few weeks by the local application of black-wash, the use of opium in small and frequently repeated doses, and complete rest in bed.

A soft chancre or an open bubo may take on a phagedenic action, and spread widely over the lower part of the abdomen, as well as over the buttocks, along the thighs and up the vagina, being accompanied by fierce and terrible pain. Owing to the looseness of the tissues about the groin and lower parts of the abdomen, they easily become infiltrated with the acrid fluids from the sore, and sloughing goes on in them very rapidly unless checked by active treatment. These ulcers, though of venereal origin, never occur as the result of syphilis. As a rule, they affect young, weakly, debauched and half-starved men and women—more especially women. Happily they are now rarely met with, at any rate in London hospitals; but I have seen one or two horrible examples of this kind of ulcer, where the muscles of the abdominal walls, and of the gluteal region and inner side of the thigh, had been cleanly dissected out by the phagedenic process, and, together with the hectic and emaciated face and wasted limbs of the terror-stricken and suffering patient, formed a sickening sight never to be forgotten.

The *treatment* of this kind of ulcer consists, in the early stage, in the application of strong nitric acid or the acid nitrate of mercury, once or twice repeated if necessary; this has in some cases converted the phagedenic sore into a healthy one, and at the same time has given quick relief from pain. If the case is not seen early, opium and tonics internally, with a good, nutritious diet, a moderate allowance of stimulants, the local application of opium, with boracic or carbolic acid lotion, and scrupulous cleanliness, must be trusted to. The prognosis is however gloomy.

ERYSIPELAS OF ABDOMEN.

Cutaneous erysipelas of the abdomen is sometimes seen as part of an attack of general erysipelas of the trunk, and spreading sometimes to the upper parts of the thighs and arms. It occurs occasionally after excision of the mamma, and the removal of tumors from the abdominal walls, and slowly spreads until it has involved the thorax, abdomen, back, and buttocks. It is generally seen in fat persons past middle age, whose kidneys are advanced in granular degeneration. It will arise in spite of the most rigid antiseptic precautions and dressings; it is not in my experience contagious, but is very dangerous to the life of the patient. It bespeaks a low degree of vitality, and though the individual may before the operation have appeared robust, the urine is generally found to be of low specific gravity, and the recuperative power exceedingly small. In five fatal cases out of seventy-three of breast-amputation which I have performed, three of the patients died from this form of erysipelas.

AFFECTIONS OF THE UMBILICUS.

EPITHELIOMA OF THE UMBILICUS is a rare disease. M. Després recently reported a case at the Société de Chirurgie, of a woman aged sixty-five upon whom he had operated, removing the tumor by two semicircular incisions. He had to remove at the same time parts of the peritoneum and omentum which were invaded by the epithelioma. The tumor removed, he plugged the wound with the omentum, and thus left an epiplocele in place of the cancer. The patient was well in a fortnight. M. Nicaise, at the same meeting, described a case of fibrous tumor of the umbilicus, in removing which he had to open the peritoneum; the patient made a good recovery. Mr. Francis Mason[1] has recorded a case of papillary tumor four inches in length and one and a-half inches in width, which he removed from the abdominal wall of a girl aged 20. The growth was congenital, and, with a similar one about the size of a pea, close to it, had never given the least pain or inconvenience locally, except through a slight, offensive discharge, which was sufficient however to prevent her from keeping a situation as domestic servant. The structure was of the ordinary warty character. The growth was excised, and five years afterwards it was known that there neither had been nor was then any recurrence.

LARGE SARCOMATOUS TUMORS of the abdominal wall are sometimes met with, and may be successfully removed even though the peritoneum is extensively implicated.[2] My Colleague, Mr. A. Clark, removed a growth of this sort which had commenced below the level of the umbilicus, on the deep aspect or in the substance of the rectus muscle, and which, after penetrating the parietal peritoneum, had involved the subjacent abdominal viscera. The whole of the disease could not be removed at the operation, and the patient died in forty-eight hours.

FLESHY POLYPI OF THE UMBILICUS originate in an error in cicatrization, and are first noticed after the umbilical cord falls off. Their size varies from that of a currant to that of a date-stone or larger, their surface is moist, and they are generally more or less pedunculated and of a bright-red color, though sometimes they are wart-like, or like a granulation-tumor. A small aperture, admitting a probe, is usually seen on the summit, and when the polypus is associated with a fecal or urachal fistula, as it sometimes is, the probe can be passed inwards a long distance. Rarely, they bleed to a dangerous and even a fatal extent. Microscopically, they consist of branched mucous glands having a fibro-nucleated stroma, and are covered and lined by epithelium of the columnar type. The *treatment* consists in ligaturing the pedicle and allowing it to dry up and fall off. If a fistula coexists, the ligature may also cure it. Mr. Holmes[1] reports a case of biliary fistula at the navel, in a boy aged ten years, in which discharge of pure bile followed the removal of one of these fleshy polypi.

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[1] Trans. Path. Soc. Lond., vol. xxii. p. 229.
[2] Lond. Med. Record, May 15, 1883, p. 170.

HÆMORRHAGE FROM THE UMBILICUS.—There is a rare form of hemorrhage from the umbilicus of new-born infants, which is almost universally fatal. It affects boys twice as often as girls, and is more fatal in the former. Its cause is a vitiated state of the blood, due to jaundice, or to a transmitted hemorrhagic or syphilitic dyscrasia, whereby the natural obliteration of the umbilical arteries is prevented, owing to the non-coagulating character of the blood. Hemorrhage of a most intractable character, either traumatic or idiopathic, may occur about the insertion of the cord before its detachment, but it generally occurs after the separation, and when the umbilicus has nearly cicatrized; thus it is within eighteen days from birth, and generally in the second week, that it commences, whilst the cord separates about the fifth or sixth day. It is fatal, on the average, within forty-eight hours; but many cases have lingered on for many days. The children have, as a rule, been well formed, have been born of healthy parents and in natural labor, and have appeared healthy at and for a few days after birth; then infantile jaundice, and in some instances purpura, has set in and preceded the hemorrhage. A combination of jaundice and purpura seems to be a precursor of certain death. In a large number of cases there has been a hereditary tendency to bleed, a tendency which, as experience has amply shown, more frequently affects the males of a family. The *treatment* consists in the use of mild but active cathartics, and of anti-hemorrhagic remedies. Compression and styptics (a piece of sponge soaked in a saturated infusion of alum or matico) are useful, but have rarely been permanently successful. Cauterization has done harm, and no good can be expected from it in any form. The ligature of the umbilicus *en masse*, with two needles transfixing it at right angles, offers the best chance of permanently arresting the bleeding.[2]

SUB-PARIETAL CONTUSION AND RUPTURE OF VISCERA.

It has been said above, and I must now repeat, that every injury to the abdomen, however slight it may appear at the time, ought to be watched with apprehension and treated with care. What is true respecting injuries to the head is equally true respecting those of the abdomen, namely, that unexpected symptoms may arise, and death ensue, from a slight blow; but that, on the other hand, violence, apparently severe, may be neither attended nor followed by any grave effect. Whilst therefore we are encouraged to hope for the best, it is our bounden duty in the interest of the patient to be suspicious of the worst, and to adopt precautions accordingly.

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[1] System of Surgery, 3d ed., vol. iii. p. 793.

[2] For further information on this subject, see a very valuable paper by Dr. Stephen Smith, in the New York Journal of Medicine, New Series, vol. xv. p. 73; and a paper on "Umbilical Hæmorrhage," by Dr. Thorold, in the Edinb. Med. Journal, September, 1863, p. 272.

It is not difficult to understand why grave results follow from slight injuries to the abdomen or to the head. We have but to remember the highly important nature of the structures contained within those cavities, their proximity to the surface, their large blood-supply and consequent liability to hemorrhage, their proneness and that of their serous coverings to inflame after injury, and the necessity of their integrity for the due performance of the complex processes of life—in fact their anatomical relations and their physiological functions—to realize the risk of injuring them.

Blows, kicks, or falls on the abdomen, the passage of a wheel over it, or some compressing force applied to its surface, are the general causes of subparietal contusions and ruptures of the abdominal organs; and these injuries frequently occur without the trace of a bruise, wound, or mark of any sort, upon the surface of the abdomen.

To facilitate description of contusions of the abdomen attended with subparietal injuries to the viscera, we may group together the contents of the abdomen after the following plan: 1. The nerve structures, chiefly of the sympathetic system, and especially the great central plexuses, the solar and hypogastric. 2. The bloodvessels of the general and portal systems, and more especially the aorta and vena cava, the hepatic, splenic, renal, and mesenteric vessels. 3. The stomach and small and large intestines. 4. The solid organs, made up largely of bloodvessels. 5. Certain receptacles and tubes, such as the gall bladder, the urinary bladder, and the uterus, which vary much in size at different times, and the ureters, Fallopian tubes, vasa deferentia, and thoracic duct. 6. The peritoneum, which extends over the whole surface of the cavity, and more or less completely envelops the several contents.

Contusion of the abdomen attended with peritonitis, whether as the result of laceration of the peritoneum or not, will be considered under "traumatic peritonitis." Contusion of the abdomen attended with injury to the sympathetic, and more especially to the solar plexus and its numerous branches, is supposed to be the explanation of those instances of sudden death from a blow on the epigastric and upper part of the umbilical regions, in which no morbid change, not even a trace of ecchymosis about the parietes, is detected after death. A blow on the pit of the stomach, or a "hit in the wind" as it is pugilistically called, causes sometimes so severe a shock as instantly to arrest the action of the heart, and death occurs from what seems a trifling blow. Sir A. Cooper, though not an eye-witness of the event, described such a case as happening near the East India House; Dr. A. Swaine Taylor has referred to one or two somewhat similar cases; and Surgeon Arthur Harding has contributed another.[1] Reference has already been made to this subject in the section on "contusion of the abdominal parietes." Contusion and rupture of several of the organs contained in the fifth of the above groups will receive notice in other articles, and there only remain therefore, for present consideration, injuries without external wound: 1, to the bloodvessels; 2, to the stomach and intestines; 3, to the solid organs; and, 4, to the gall-bladder, the hepatic and common ducts, the ureter, and the thoracic duct.

CONTUSION AND RUPTURE OF THE ABDOMINAL BLOODVESSELS.—The aorta, vena cava, cœliac axis, mesenteric, spermatic, and other chief vessels of the abdomen, are ruptured either by a smart, forcible blow, or by a severe crushing violence, such as the passage of a wheel of a wagon, etc. In the case of the aorta the rupture is generally transverse, but occasionally oblique; sometimes it is a clean rent, sometimes irregular and angular; occasionally it is entirely across, but more frequently not; in some instances all the coats are torn, in others the internal and middle coats only are divided, and become inverted and retracted within the stronger outer coat in the same manner as after the employment of Fleet Spier's artery-constrictor.[1] In the Museum of the Middlesex Hospital there are two beautiful samples of this form of rupture. Instances of rupture of the vena cava have been recorded by Breschet, Richerand, Velpeau, and Poland. Poland[2] has also recorded a case of death from hemorrhage, from a branch or branches of the vena porta at their entrance into the liver. The woman was run over when intoxicated; there was no external sign of injury; she referred all her pain to the scrobiculus cordis and the left hypochondrium; but at the post-mortem examination there were three pints of coagulated blood in the abdomen, and copious effusion behind the peritoneum, derived from the torn vessels, but no laceration of liver or spleen, all the organs being healthy. Dr. McNaughton records a case of death from rupture of the right ovarian or spermatic vein.[3] Prof. Gross cites a fatal case of laceration of the splenic vein.[4] Veins within the abdomen have been known to burst spontaneously during the cold stages of ague.

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[1] Army Med. Department Report, vol. xxi., Appendix No. vii. 1881; and Holmes's system of Surgery, 3d ed. vol. i. p. 867.

One of the results of contusion of an artery is aneurism. This is more likely to follow if the inner coats are lacerated, and the external weakened but not torn by the blow. In the Guy's Hospital Reports for 1851,[5] Dr. Lever records a case of aneurism of the common iliac, caused by a blow, in a female aged 33. Aneurism of the right superior mesenteric artery has arisen in the same way.

The *symptoms* will vary according to the size of the vessel injured, and will depend upon whether the rupture is complete and attended with hemorrhage, or incomplete and unattended by bleeding. If the rupture be completely through all the coats, and the vessel be of some size, hemorrhage, and collapse with syncope, will be extreme. If the rupture affect only some of the coats, or if a vessel be seriously contused without any of the coats being lacerated, hemorrhage will not occur; but the evil consequences of the injury will be shown at a later period in gangrene, or in the results of a diminished blood-flow owing to permanent narrowing of the calibre of the vessel at the contused part, or in the formation of an aneurism. Usually these injuries to the vessels are complicated by lesions of other organs, which add to the fatality of accidents sufficiently dangerous and fatal of themselves. It is not seldom that both artery and veins are injured together, and then if death does not ensue from hemorrhage, it almost certainly will from gangrene.

The *diagnosis* of these injuries is difficult, and is often complicated by the presence of other lesions, produced by the same accident. The *prognosis* is most unfavorable, the least dangerous being the incomplete ruptures, and the contusions without rupture of any of the coats.

Treatment.—If there be time for the adoption of any line of treatment, this should consist in the maintenance of absolute rest in the recumbent position, in a cool air, with the application of ice to the abdomen; opium should be given to relieve pain and quiet the circulation. With evidence of hemorrhage continuously going on, or recurring a few days after the injury, the abdomen should be opened and the bleeding vessel searched for. Desperate as such a course may seem, it is preferable to allowing the patient to die from hemorrhage which might prove controllable. But the bleeding may be so sudden and profuse that no time is allowed for the adoption of any treatment. Such was the condition in the case of laceration of the aorta, recorded by M. Legouest.[1] A farrier received a kick from a horse, near the umbilicus, causing a transverse laceration of the left side of the aorta, one-fourth of an inch in length, and three fingers' breadth above the promontory of the sacrum; the hemorrhage was rapidly fatal.

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[1] See Figs. 396—402, Vol. III., page 98, *supra*.

[2] Prize Essay.

[3] Edin. Med. and Surg. Jour., 1841, p. 253.

[4] System of Surgery, 5th ed., vol. ii. p. 687.

[5] Guy's Hosp. Reports, 2d series, vol. vii. p. 130.

CONTUSION AND RUPTURE OF THE STOMACH AND SMALL AND LARGE INTESTINES.—*Contusions of the gastro-intestinal tube* are apt to be followed by acute or chronic inflammation of some or all of the coats of the part injured. Traumatic gastritis, enteritis, cæcitis, and colitis, whether of the acute or chronic form, present the same symptoms as when occurring idiopathically or from poison. The symptoms of these diseases are to be found described in works on medicine, but as they occasionally occur in surgical practice, it is necessary for the surgeon to be familiar with their diagnosis and treatment.

Briefly, then, it may be said that *acute* inflammation of the stomach or intestines is attended by severe local pain of a persistent character, but interrupted by paroxysms of pain still sharper; by acute tenderness on pressure, much febrile disturbance, thirst, nausea, vomiting, and abdominal distension; by hurried and often painful respiration, a small, frequent, wiry, or thready pulse, constipation, scanty and high-colored urine, a feeling of inward burning, exhaustion, and a countenance pinched and expressive of great distress. If the case goes on to a fatal termination, the patient rapidly emaciates, and has a dark, sunken look about the eyes; his hands and feet become blue and cold; cold sweats suffuse the face and extremities, the pulse intermits, hiccough sometimes occurs, a drowsy stupor with wandering delirium supervenes, the sphincters relax, possibly all pain ceases, and the patient, having been brought to death's door by way of asthenia, often hovers before it for a longer or shorter time, and then, in a manner quite suddenly, vanishes through cardiac syncope. The diagnosis of gastritis, enteritis, etc., from local, acute peritonitis, is very difficult, and sometimes quite impossible; but from the point of view of treatment this matters little, since these affections are but peritonitis with something more—namely, inflammation of the areolar and muscular tissues, as well as of the peritoneal coat.

The symptoms of *chronic* inflammation of the various parts of the gastro-intestinal tube are frequently very obscure, and simulate chronic peritonitis. For their description we must refer to works on medicine. The surgeon must bear in mind, however, that chronic gastritis may run on into ulceration, sloughing, gastro-abdominal fistula, and permanent contraction from thickening of the coats, or from cicatrization after ulceration. Similar results follow from chronic inflammation of any part of the intestinal tube. Complete intestinal obstruction may be caused by the thickening and contraction of the walls of the intestine after contusion. Many years ago, a very typical case of this sort was communicated to the Académie de Chirurgie by M. Braillet,[2] and other somewhat similar cases have been recorded since.

Reference will again be made to gastric and fecal fistulæ arising from contusions and other injuries to the coats of the viscera.

Rupture of the stomach or intestines is probably more frequent, and certainly much more fatal, than simple contusion. Rarely is the rupture confined to one coat, either serous or mucous, but generally the whole of the coats are lacerated. *Rupture of the stomach* is more rare than rupture of the intestine, owing to its smaller extent and deeper position, when not distended, when also it is protected by the ribs and costal cartilages, and by the liver. Incomplete rupture of the stomach is occasionally found in persons who have died of rupture of other organs, or of other injuries. Sometimes the mucous, sometimes the peritoneal coat alone is lacerated. Poland writes:—

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[1] Chirurgie d' Armée, 2e éd., p. 372.

[2] Memoir of Hévin on Gastrotomy. Poland quotes this case; see Guy's Hospital Reports, 3d series, vol. iv. p. 136, and Prize Essay, MS.

> Rupture of the stomach may be complete or incomplete, affecting one, two, or more coats at a time. Devergie remarks: "If it be the outer coat, there are generally observed, and principally at the lesser curvature, five, twenty or thirty tears, with clean borders, half an inch to an inch long, without separation of the edges. Similar tears are observed on the mucous coat, and it is remarkable that these often exist just at the point opposite to the external tear. Their direction is from before backwards." He adduces several cases in support of this view; we, however, have only observed partial laceration of the peritoneal coat, to some extent, with considerable ecchymosis; here, however, there was rupture of the spleen as well. In another there was extensive laceration and hanging in shreds of the mucous lining of the stomach, caused by the wheel of a cart passing over the abdomen; here, also, there was extensive laceration of the liver.[1]

Where all the coats are ruptured, death may ensue at once by shock or collapse, or precisely the same symptoms may occur as follow wounds of the stomach. The situation of a rupture of the stomach varies: it may be at the cardiac or pyloric extremity on either aspect, or along either curve. It may be torn quite across at the pylorus; or the rent may be oblique, or in the long axis of the viscus. The post-mortem records of the Middlesex Hospital contain the details of the case of a boy, aged nineteen years, who was killed in a railway accident: There was a linear rent in the stomach, $1\frac{1}{4}$ inches in length and extending through all its coats, about the middle of the great curvature; almost the entire stomach, with its contents, and the left lobe of the liver, were displaced into the left pleural cavity through an opening in the left side of the diaphragm, measuring 12 inches in circumference.

Rupture of the small and large intestines may be either partial or complete. Partial ruptures give rise to no special symptoms whereby they can be diagnosed, and they are not seldom healed by localized peritonitis. This is proved by what is observed after death, as well as inferentially from what is seen to exist in some cases of hernia and of abdominal section, which have ended in recovery, and in which considerable lacerations of the serous coat of inflamed and softened bowels, observed at the time of the operation, have been repaired. Cases in which bright blood has been passed by the rectum shortly after an injury over the colon or sigmoid flexure, by persons previously healthy, suggest that lacerations of the mucous membrane of the large gut may occur from contusion of the abdomen, and that such lacerations are readily recoverable. Complete rupture of the bowel may occur from very slight causes, especially if of the nature of a smart, quick blow upon the abdomen. Complete rupture does not necessarily deprive a person of the power of locomotion. Taylor refers to a case in which the duodenum was completely torn across, and yet the patient, a boy aged thirteen, walked a mile with but little assistance, and died in thirteen hours. He also refers to a case, in a young girl, in which the jejunum was ruptured by a blow with a pebble. Other cases are on record which prove that complete rupture of the intestine—that is, laceration through all its coats—may be followed for several hours by complete immunity from symptoms. In one case, a man whose ileum was rent in two places walked to bed and undressed himself.[1] Key has recorded the case of a man who continued at work, carrying sacks of flour to a vessel, after traumatic rupture of the bowel in a hernia. Dr. E. K. Sanborne had a patient who was struck on the abdomen by the handle of a hand-cart, and died in forty-six hours of complete rupture of the gut; but he was able to wheel his cart across a yard after the blow.[2] Dr. Bristowe[3] records the case of a man who fell and suffered a circular laceration of the sigmoid flexure, half an inch in diameter, through which mucous membrane projected, and through which fetid gas and fecal matter had escaped into the peritoneal cavity. There had been no pain at first, and for three hours there had been no collapse. The accident happened at 5.30 P.M., at 9 o'clock collapse came on, and at 1 A.M. he was dead.

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[1] Poland, Prize Essay; see also Guy's Hospital Reports, 3d series, vol. iv. pp. 132, 133.

Complete division of the small intestine from a blow on the belly has been recorded, no effusion of the contents following. In one case the patient lived eight days, and, owing to the tight contraction of the circular fibres of each end of the divided gut, there was no escape of fecal matter.[4] A similar, complete division of the cystic duct without the escape of bile, will be referred to hereafter.

Rupture of the intestine occurs at any part of the small or large bowel, from the commencement of the duodenum to the lower part of the sigmoid flexure. The *duodenum* being the most fixed portion of the intestine, might be thought to be most liable to rupture from injury; but its deep situation behind the liver and transverse mesocolon protects it. As a matter of fact, it is very rarely torn. Poland's[5] collection of 63 instances of ruptured gut, contains only 4 cases of ruptured duodenum, all of which were fatal at periods varying from five hours to three days after the injury. The *jejunum* was ruptured 14 times out of the 62. In 7 cases the rent was near the duodenum, and in 3 the jejunum had been forcibly torn away at its junction with the duodenum, its most fixed point. In other cases of ruptured jejunum the rent was in the central or lower parts, and extended through from one-quarter to three-quarters of its circumference. The *ileum* seems to be about as frequently ruptured as the jejunum, or even more so; like the jejunum it may be completely torn across, or ruptured to any less extent of its circumference. The large intestine is not much more frequently ruptured than the duodenum or stomach, and very much less frequently than the jejunum or ileum. The *cæcum* is more liable to rupture than the ascending or descending colon. The *sigmoid flexure* itself may be ruptured, or it may be torn away from the rectum.[6] Poland[7] quotes five cases of ruptured large intestine out of sixty-three of ruptured gut; of these five, two were of the cæcum, two of the sigmoid flexure, and one of the descending colon. Morineau[8] gives an instance of rupture of the *ascending colon*.[9]

The rupture may vary in extent from a mere pin-hole, to a rent two,[10] six,[11] or more inches long in the stomach, or to a complete tearing asunder of the gut, together with its mesentery. If the rent is incomplete or very small, and if the viscus is not much distended at the time, extravasation into the peritoneal cavity may not occur; otherwise the escape of some of the contents is all but inevitable, and death from intense peritonitis must follow. It is improbable that complete rupture of either the stomach or bowel, from contusion, ever takes place unless the viscus is more or less distended; and there are no facts to lead us to suppose that complete rupture without an external wound has ever been otherwise than fatal. Ruptures of the gastro-intestinal tubes are more fatal than wounds of the same part.

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[1] Poland, Guy's Hospital Reports, 3d series, vol. iv. p. 155.

[2] Agnew, Principles and Practice of Surgery, vol. i. p. 356.

[3] Trans. Path. Soc. Lond., vol. ii. p. 94.

[4] Ibid., vol. xii. p. 109.

[5] Guy's Hospital Reports, 3d series, vol. iv. pp. 123 *et seq.*

[6] Hole's case, Lancet, vol. i. 1851, p. 381.

[7] Loc. cit.

[8] Gaz. Méd., p. 788. 1852.

[9] For references to several other cases, see Medical and Surgical History of the War of the Rebellion, Part Second, Surgical Volume, p. 22. To the vast amount of facts and references contained in this wonderful compilation I am deeply indebted.

[10] Collins, Boston Med. and Surgical Journal, vol. lxxiii. p. 202.

[11] Roques, Jour. Gén. de Méd., etc., tome lxv. p. 351.

Symptoms.—The immediate results of rupture of the gastro-intestinal tube are not the same in all cases; thus, in one instance, extreme collapse, sudden and excessive meteorism, intense suffering, and rapid death within an hour or two, will be witnessed; whilst in another the patient will be able to walk, or will be comparatively free from pain for a long time or altogether, and death may be delayed for three or four days. There are certain features common to rupture of the stomach and rupture of the intestine, and it will save repetition to consider both classes together. These symptoms may be divided into immediate and subsequent. The immediate symptoms are faintness and collapse, succeeded by intense pain which soon becomes agonizing, is of a burning character, and spread all over the abdomen; the face is anxious and assumes sometimes a hippocratic expression; the pulse may be slow, feeble, and intermitting, or it may be natural for a time, until peritonitis sets in; rigors occasionally occur; thirst is complained of, and vomiting takes place, first of the stomach's contents, then of blood, and lastly, it may be, of blood and bile; the abdomen becomes either tympanitic and tender, or flat and rigid from muscular contraction; finally, there may be retention of urine. The subsequent symptoms are such as are excited by traumatic peritonitis, and will be described in their proper place.

Diagnosis.—This is usually not difficult. Prolonged collapse, sudden tympanites, agonizing pain, acute tenderness of the abdomen with, probably, absence of external injury, blood in the vomited matter or in the stools, but without evidence of marked internal hemorrhage—these, following the receipt of a blow upon the abdomen, are very characteristic symptoms, though they are not all uniformly present. Distinction must be made between cases of primary rupture, which at once present such symptoms as the above, and cases of perforation of the coats which follow several days—it may be thirteen or fourteen days—after an injury, and which are due to ulceration of the contused parts of the viscera. The symptoms of the latter cases are for a time insidious, but as soon as perforation is approaching, the collapse and abdominal pain and distension become well marked. If violence is inflicted upon the inguinal region, or upon a scrotal hernia, the symptoms of ruptured bowel may be erroneously referred to damage to the testicle or cord, but the hippocratic expression, together with the continued and increasing severity of the symptoms, will sufficiently indicate the more serious nature of the accident. The symptoms following a bruise of the intestine may simulate rupture of the bowel, but they are less severe, more transient, and more amenable to mild and soothing treatment. It is well for the surgeon to bear in mind that instant death may arise from the sudden perforation of a cancerous or simple ulcer of the stomach or intestine, and that as the death-stroke may be followed by a fall, doubt may possibly be raised as to the cause of the rupture, just as it is sometimes raised in cases of apoplexy and falls on the head, as to whether the extravasation is due to the fall, or the fall to the extravasation. A post-mortem examination will however clear up the question in the case of the intestine. In a case related by Guthrie, of a boy who was struck in the abdomen by a piece of wadding discharged from a gun, and who then fell from a tree and shortly died of ruptured ileum, a nice medico-legal point might have been raised, namely, as to whether the fall or the blow from the wadding was the cause of the rupture.

Perforation of the stomach by gastric solution has been mistaken for rupture of the organ. Such a mistake might lead to serious consequences if an injury had been inflicted by another individual prior to the patient's death.

Prognosis.—It has been already stated that death is almost the inevitable termination of rupture of the membranous viscera. It may occur either in the primary stage, from collapse, or in the later stage, from peritonitis, or from intestinal obstruction due to contraction of the injured bowel; and it has been caused some weeks after the closure of the rent by pyæmia. If recovery takes place, it is because the rent is very small and soon closed by adhesions, or by prolapse of the mucous membrane, or by the opening becoming plugged by a mass of omentum, thus preventing the escape of the visceral contents, as in the case of Jobert (de Lamballe). Death after rupture of the stomach or duodenum occurs generally in from three hours to five days, but it is possible that some of the cases of supposed recovery from chronic gastritis have really been recoveries from slight or partial rupture, in which the lacerated coats have been healed, or glued to the surrounding parts by traumatic peritonitis. Poland[1] gives abstracts of 64 fatal cases of ruptured stomach and bowels, and out of 57 in which the time of death is stated, 10 were fatal in five hours, 17 in from five to twenty-four hours, 20 in from twenty-four to forty-eight hours, 9 between the third and sixteenth days, during the period of repair, and one after two months. Stromeyer[2] cites a case of abdominal contusion in which hæmatemesis recurred on the fourteenth day, and in which, at the autopsy, a rupture of the stomach was found.

Treatment.—Every care must be taken to keep the injured viscus absolutely quiet, so that repair may be effected. To this end, the first and most essential rule to observe is, "Never give a drop of fluid or a particle of solid food, for forty-eight hours at least—this is the golden rule."[3] After this period, small quantities at a time of food, such as jelly, beef tea, or milk, may be taken by the mouth. There is no doubt that the chances of recovery have been quite destroyed by the neglect of these precautions, as the presence of brandy and water, and of castor oil, administered after the accident and found after death floating freely amongst the coils of intestines within the peritoneal cavity, has too plainly proved. Small fragments of ice, or a little piece of pellitory root to suck, or acidulated water, painted from time to time on the fauces, will allay thirst. Stimulants and purgatives must be avoided. Poland,[4] in drawing attention to this class of injuries, writes: "We have been mainly influenced by the fact that much injudicious and careless (we might almost say reckless) treatment has been resorted to. In the numerous instances here collected, we have sad specimens of the action of purgatives in hurrying the unfortunate patient to a more speedy and inevitable death." The recumbent position, with the knees raised and supported by a pillow, must be observed; subcutaneous injections of morphia, or opium in small and frequently repeated doses, should be given; and hot fomentations or poppy-head stupes should be applied to the abdomen. As retention of urine is prone to occur after these as after most other injuries, this should be looked for and relieved if necessary by the catheter. If the patient survives the first shock of the injury, and peritonitis or intestinal obstruction supervenes, the treatment requisite for those conditions must be adopted.

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[1] Guy's Hosp. Reports, 3d series, vol. iv. p. 123.

[2] See Med. and Surg. Hist. of the War of the Rebellion, Part Second, Surgical Volume, p. 22. Dr. Otis gives references to several cases of rupture of the stomach and intestines.

[3] Poland, loc. cit., p. 129.

[4] Ibid., p. 167.

The question of laparotomy ought to be considered, for though the difficulties both of diagnosis and of discovery of the ruptured point are great, yet nothing can be hoped for from expectant treatment if the rupture is complete and extensive through the bowel's coats. Though life in some cases has been prolonged for many days, the result is death, though the end may be delayed.

Prof. Albert,[1] of Vienna, has, for some years past, laid it down as a rule, that no clearer indications for laparotomy can be furnished than those given by rupture of the intestine.

Ruptures of the Omentum and Mesentery.—Such lacerations, though rare, occur occasionally without any external mark of contusion of the parietes. Prof. Gross[2] mentions a fatal case of rupture of the omentum, and in the History of the War of the Rebellion an interesting example of rupture of the mesentery is noted, in which some of the intestines became strangulated in the rent. A second case, if not of rupture at least of contusion of the mesentery, followed by abscess in the abdominal wall and mesentery, and by suppurative peritonitis, is related in the same work. The following cases are taken from the Post-mortem Record of the Middlesex Hospital:—

Rupture of Mesentery and of Inner Coat of Aorta, with Retroperitoneal Extravasation of Blood.—In December, 1880, a man, aged seventy, was admitted into the Middlesex Hospital, under the care of Mr. Hulke, with fractures of the fifth, sixth, seventh, eighth, and ninth ribs on the right side, and died the following day. There were some slight cutaneous bruises, and at the post-mortem examination some blood was found extravasated into the muscles of the left lumbar and iliac regions, and a considerable quantity into the muscles and tissues about the fractured ribs. The visceral and parietal peritoneum showed signs of recent, general peritonitis, most marked on the left side of the abdominal and pelvic cavities. Pus was beginning to form upon some of the coils of intestine. Nearly a pint of blood was found in the peritoneal cavity, and a large clot was between the left lobe of the liver and the diaphragm. The blood had come from ruptured vessels of the mesentery of the ileum, near its centre. A rent existed in this part of the mesentery, three and one-half inches in length, its edges ragged, and covered with adherent blood-clot. At several points small ecchymoses were seen in the mesentery; two of these, larger than the others, were nearly the size of florins. Two inches below the origin of the cœliac axis, a rent half an inch in length was found in the inner coat of the abdominal aorta; no extravasation of blood between the coats of the aorta had occurred at this spot; the vessel, however, for five inches of its course along the abdomen, was surrounded by dark clot, the source of which appeared to be one of the lumbar arteries which was full of clot, though this could not be absolutely decided. (Post-mortem Report, No. 205. 1880.)

In another case, admitted into the Middlesex Hospital under the care of Mr. Lawson, in January, 1879, the mesentery, which was fairly loaded with fat, was torn in three places. The largest of these lacerations extended about half way between the ileum and the spine, and admitted of the passage of four fingers; the margins of the rent were ragged, and blood was extravasated between the folds of the membrane. The other two rents were the size of sixpences, and were close to the larger one. There was no rupture of intestine or other organ. A quantity of blood was in the peritoneum, and peritonitis had commenced. The man died on the second day. (Post-mortem Report, No. 4. 1879.)

More or less severe extravasation of blood must be looked for in these accidents, and is most likely to prove fatal in a few hours. If life is prolonged, the edges of the wound may be healed by adhesions with adjacent parts, but if suppuration once occurs, it is prone to spread wide and far in the loose tissues of either mesentery or omentum.

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[1] Wien. med. Woch., No. 47. 1881.

[2] System of Surgery, vol. ii. p. 679.

Contusion and Rupture of Hernia.—Cases have been reported by S. Cooper,[1] Watson,[2] Poland,[3] and others, of rupture of the intestine from kicks or blows inflicted upon individuals the subject of hernia, though the part of the bowel ruptured was not that contained within the hernial sac. Such accidents have more frequently happened to men with inguinal or scrotal herniæ than to women; but one case, which was the subject of medico-legal inquiry, occurred in a woman with femoral hernia. This case, which is reported by Watson, was that of a woman who was struck by her husband on the abdomen, and died in twelve hours; the ruptured bowel was at a distance from the hernia, but opposite to a bruise on the abdominal wall; and as there was no fecal matter in, nor inflammation of, the sac, the husband was convicted. The following case was under the care of Mr. Hulke:—

A man, seventy years of age, was brought into the Middlesex Hospital on the 8th of February, 1881, with fracture of the pelvis and rupture of the urethra, for which perineal section was performed. He died the same day. At the post-mortem examination, a hernial sac in the right inguinal region was found to contain coils of ileum about eleven and one-half inches long, and at the entrance into the sac a transverse rupture of the gut had occurred, the coats being divided almost as cleanly as if they had been cut. Some fluid feces had escaped into the peritoneal cavity, and had set up acute general peritonitis; the intestines were distended with flatus and fecal matter.

Another class of cases, and one to which Aston Key[4] and Poland[5] have drawn special attention, is that in which the portion of the bowel within the hernial sac has received the blow. These injuries also occur chiefly in males with inguinal, or more especially with scrotal herniæ. In some cases the hernia has been reducible, and a truss has been worn, but, the blow having forced aside the pad of the truss, the bowel has received the effects of the violence. In other cases, the violence has been received directly upon an irreducible hernia; in a few, the injury has been inflicted whilst the bowel has been held in place by a truss. The injury may result in (1) contusion, followed by inflammation of the coats of the intestine, and of the sac; (2) contusion, followed by sloughing of the intestine, if the vitality of its coats has been destroyed; (3) rupture of the bowel. These three conditions are attended by the symptoms which arise in cases of corresponding injury to bowel not contained within a hernial sac, with, generally, this additional one, namely, that the soft parts about the hernial region become red and œdematous, and may threaten to or do actually burst. If the bowel have ruptured, the fecal extravasation, though it takes place first into the sac, will soon find its way into the general cavity of the peritoneum, unless an incision be made into the sac as in operating for strangulated hernia.

Prognosis.—In all the cases of which I am aware, in which the bowel has been ruptured by the injury, death has followed. In two cases reported by Key, in which, after injury to the hernia, acute inflammatory symptoms and vomiting set in, the sac was laid open, and, though the bowel subsequently sloughed, the resulting artificial anus closed spontaneously, and complete recovery took place, in one case in four, in the other in ten weeks.

Treatment.—In all cases in which a hernia has been injured, the hernial sac should be laid open if there be severe local or constitutional symptoms, whether the bowel be in the hernial sac or not when the patient is seen. Reduction of the hernia by taxis should never be attempted if there be or have been symptoms indicative of severe contusion of the bowel. It may happen that the symptoms of severe inflammation of the coats of the bowel arise after reduction has been effected, in a case in which the slightness of the shock and the rapidity of the reaction dissipated all fear at the time, and induced the surgeon to employ a gentle taxis. Aston Key, however, was of opinion that in such a case the danger of fecal extravasation would not be increased by the replacement of the injured bowel near the neck of the sac; for should sloughing ensue, the slough might be walled in by adhesions of the surrounding peritoneum, and fecal extravasation would be thereby prevented; or if the salutary process of adhesion failed to insulate the slough, the sac would receive the fecal matter, and quietly give intelligence of the mischief by the tumefaction which would ensue in the parts outside.

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[1] Dictionary of Surgery.

[2] Treatise on Homicide, pp. 77 *et seq.*

[3] Guy's Hosp. Rep., 3d ser., vol. iv. p. 155.

[4] Ibid., 1st ser., vol. vii. pp. 264 *et seq.*

[5] Ibid., 3d ser., vol. iv. pp. 157 *et seq.*

Rupture of the Solid Viscera.—Rupture of the solid viscera may occur in the same manner as sub-parietal rupture of the hollow viscera or blood-vessels, without any wound or visible contusion of the abdominal wall. Blows, falls, kicks, or compression, are the common causes of such accidents. It is stated by Taylor,[1] on the authority of Male,[2] that the liver may be ruptured merely by a sudden action of the abdominal muscles; and Taylor likewise refers to a case[3] in which a fall on the feet from an elevation produced laceration of this organ. Sometimes two or more of the solid viscera are lacerated by the same violence. In a man brought into one of my beds at the Middlesex Hospital, over whose body a wagon had passed, there were found after death lacerations of the liver, spleen, left kidney and supra-renal capsule, left lung, and pericardium, as well as several broken ribs, and a comminuted fracture of the tibia. Any of the solid organs of the abdomen may be torn in one place, or in several; their peritoneal coat may not be lacerated, though most frequently it is. The liver, the spleen, and more rarely, but still occasionally, the kidney and its supra-renal capsule, may be injured by broken ribs, but if so, the diaphragm is, as a rule, perforated also. I have before me as I write the notes of several such cases taken from the records of the Middlesex Hospital. Ruptures of these organs are generally fatal from hemorrhage and shock within a few hours; occasionally life is prolonged for two, three, or more days, and is terminated by recurrent or slowly continued hemorrhage, or by peritonitis. Mackmurdo[4] had a case in St. Thomas's Hospital, of extensive laceration of the liver, and the patient survived seven weeks. The man, aged twenty-three years, remained collapsed for forty-eight hours, and then slowly revived. Peritonitis supervened, and the abdomen swelled; there was distinct fluctuation detected on the right side of the belly; and the patient died from suppression of breathing due to the upward displacement—as high as the third rib and second dorsal vertebra—of the right leaflet of the diaphragm and right lung, by a circumscribed collection of serum, blood, blood clot, and bile-stained lymph. Recovery may, however, be the result if the injury is confined to one organ, and is not very extensive; when the peritoneal covering is unbroken, the chance of recovery is greater, although abscess of the liver may result. As it is quite impossible to diagnose laceration of the substance, unaccompanied by laceration of the capsule, of these organs, there is always the suspicion, in cases which recover, that the injury has been merely a contusion followed by localized peritonitis, unless abscess of the injured organ has formed. The proof of the cicatrization of wounds of the solid viscera is found in persons who have lived for some weeks after the rupture, and have died of suppuration or of some associate injury; or who have altogether recovered from the injury, and have subsequently died from some other cause. Such was the case reported in a paper by Athol Johnson,[1] of a man aged 38, who ruptured his liver and right kidney, and fractured his seventh cervical vertebra. He died from the effects of the injury to the spine three weeks after the accident, and at the post-mortem examination it was seen that an extensive rupture of the upper surface of the right lobe of the liver, five inches in length, "was perfectly united, with the exception of some few points where the peritoneal coat still remained broken; but no lymph was found on the serous membrane, which retained its polished appearance. The rupture did not extend very deeply into the organ. Several ruptures beautifully united, but not extending more than two lines in depth, were found on the anterior surface of the right kidney; no inflammation existed about this organ." In a case reported by Dr. Walter Fergus, there was also fair evidence of repair.[2]

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[1] Med. Jurisprudence, p. 449. 1865.

[2] Epitome of Juridical or Forensic Medicine, p. 119.

[3] Ann. d'Hygiène, t. i., p. 133. 1846.

[4] Trans. Path. Soc. Lond., vol. iii. p. 344.

Rupture of the Liver.—The liver may be completely broken through, or the rupture may be limited to either its upper or lower surface. Out of twenty-two fatal cases of injury to the liver which occurred at Guy's Hospital, between 1867 and 1872, the damage in the greater number (fourteen) was extensive. In six cases the liver was partially or entirely divided in an antero-posterior direction; in eight it was severely lacerated in various directions; and slighter injuries of the upper surface occurred in only two, and of the under surface in only three of the number.[3] The liver, as I have seen, may be divided from before backwards through its whole thickness; or an irregularly shaped mass may be broken away from the rest and found lying loose in the abdomen; or the gall-bladder, with the adjacent part of the liver-substance, may be rent off from the surrounding parts. Dr. Alexander Kilgour[4] has recorded the case of a man who was said to have had his belly jumped upon, and who died in great pain on the second day after. At the autopsy, the gall-bladder, half distended with bile and blood, was found loose and quite separated from its connections. Some coagula, and one hundred and twenty ounces of fluid blood, were found in the peritoneal cavity, and upon the rough, under surface of the liver from which the gall-bladder had been torn away.[5] A very frequent situation of rupture from external compression, when the ribs are not broken, is the upper surface of the right lobe near its posterior border; the laceration in these cases may be transverse, or stellate, and of several inches in length, with ragged edges, and it may extend deeply into or through the liver-substance. It would seem that in these cases the injury affects, not as might be expected the part compressed, but the most protected part, owing to the forcible doubling up of the liver upon itself. Sometimes it is the back part of the under surface of the right lobe which yields, and then large quantities of blood are poured into the cavity of the peritoneum, in front of and behind the stomach. When the upper and back part of the right lobe is torn, the effused blood may push up the diaphragm so as to make it encroach considerably upon the pleural cavity, as in Mackmurdo's case already referred to.

When injured by the broken ends of ribs, there will be two or more superficial rents or punctured wounds, which at the post-mortem examination will be found covered with blood-clot. In a case recently in the post-mortem room at the Middlesex Hospital, the liver of a man who had been found dead in the street, was marked by one oblong, sub-peritoneal contusion, attended with pulping and effusion of blood, five inches long, exactly corresponding to the shape and position of the ninth rib, the tissues on which were also ecchymosed. I have reported a remarkable case of slight rupture of the liver-substance at a part where a hydatid cyst had been developed. The cyst was also ruptured and detached from the surrounding liver-tissue, and some hemorrhage into it had occurred from the torn surface of the organ. The liver-capsule was quite intact. The patient died of shock. Ogston[1] says that of 26 ruptures of the liver, in 9 the seats of rupture were in the right lobe, in 11 in the left lobe, and in 6 in the central parts. Of these, 9 took the antero-posterior direction and 2 the transverse, the others being irregular.

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[1] Med.-Chir. Trans., vol. xxxiv. p. 55.

[2] Ibid., vol. xxxi. p. 45.

[3] Dr. Frederick Taylor, Guy's Hosp. Rep., 3d ser., vol. xix. p. 261.

[4] Edinburgh Med. and Surg. Journal, p. 352. 1841.

[5] A similar case, recorded by Ogston, is referred to in the section on Rupture of the Gall-bladder.

It is curious that, though the liver-substance is often torn right up to the side of the hepatic portion of the vena cava, or the laceration even runs parallel for a long distance with a large branch of the hepatic vein, the coats of these vessels so often escape injury. A case related by Dr. Pearson,[2] and several others on record, justify this statement. In Pearson's case, remarkable for more reasons than one, the liver was completely divided obliquely, and the two portions were held together only by the vena cava and the trunks of the venæ cavæ hepaticæ. In a man brought into the Middlesex Hospital dead, the liver was lacerated completely across its right lobe, the portions of which were only held together by a few vessels which had escaped being torn. I have notes of other cases in which the same condition was found.

The *symptoms* of ruptured liver are extreme pallor and coldness of the surface; difficult and short, or sighing, breathing; small, feeble pulse; abdominal pain and distension, the distension not being entirely tympanitic; sense of sinking and vomiting, with sometimes great thirst; and occasionally itching of the skin, and jaundice if the patient live more than twenty-four hours. Diabetes has been said by Bernard to follow injuries to the liver. If death does not occur from hemorrhage or collapse, there are the risks of peritonitis, and at a still later period of abscess of the liver, or of abscesses between the liver and some of its surroundings. After peritonitis has set in, there will be great tympanites, and as this subsides, dulness on percussion may be detected either in the flanks or in some circumscribed area about the liver. This dulness is due partly to extravasation, and partly no doubt to inflammatory effusion, and it may disappear in part or entirely if the patient survive a few weeks.

Rupture of the spleen is less common than rupture of the liver, and when it occurs it is frequently accompanied by injury to other abdominal or thoracic organs, and especially to the liver itself. It is often associated with fractured ribs. Spontaneous rupture of the spleen, according to Rokitansky and others, occurs in typhus and typhoid fevers, cholera, and the hot stage of ague, and leads to death from hemorrhage. Hemorrhage is the chief cause of death after traumatic rupture of the spleen, but though this organ is more vascular than any other in the abdomen, uncomplicated injuries to it are not as quickly fatal as injuries to the liver. This, perhaps, is attributable to the great elasticity of the splenic capsule and trabeculæ. If the splenic vein or artery be torn, death will be almost instantaneous, as in the case, detailed by Hennen,[3] of the soldier who received a violent blow in the abdomen whilst fighting, and died in a few minutes from rupture of the spleen and splenic vein. In another case,[4] rapid death from hemorrhage followed after rupture of the spleen, but here the spleen was enlarged and very soft; the rupture was caused by a blow from a boy who in stature scarcely reached the waist of the man he killed. M. Vigla[1] and M. Collin[2] have published exhaustive papers on ruptures of the spleen, in diseased subjects, from muscular contraction or very slight external violence. If death from hemorrhage is escaped, abscess, and, less frequently, peritonitis, may cause the fatal result.

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[1] British and Foreign Med.-Chir. Review, vol. xxxix. p. 204. 1867.

[2] Medical Transactions published by the College of Physicians in London, vol. iii. p. 377.

[3] Op. cit., p. 445.

[4] Medico-Chirurgical Review, October, 1839.

In a case reported by Mr. Davy,[3] the portion of the spleen corresponding to the suspensory ligament was completely crushed off from the rest, and an antero-posterior rent nearly severed the remaining five-sixths of the organ at its middle. There were three short, linear rents in the splenic capsule, and the liver also was ruptured. Death occurred in two hours. There can be no doubt that in some instances rupture of the spleen, as of the liver, has been an after-result, and due to some movement of the patient whereby the broken end of a rib has been driven into the organ. Such a case was under the care of Mr. Campbell de Morgan,[4] in the Middlesex Hospital, in 1872:—

A man, aged thirty-two, fell 25 feet, broke several ribs, and received other slighter injuries; emphysema followed on the left side; and he was sick, thirsty, suffered much pain in the præcordia, and could not pass his urine, but quickly rallied, and on the following day was doing well; thus he continued until the following day, when he was seized with delirium tremens and struggled violently; he then sank rapidly and died the next morning. The post-mortem examination showed that there had been a perforation of the ileum, which had become glued to the diaphragm, and that the broken end of a rib had projected through the diaphragm into a large rent in the spleen, from which extensive hemorrhage had taken place into the abdominal cavity. Both the clinical and post-mortem conditions of this case were opposed to the idea that the splenic lesion had been caused at the time of the accident.

The spleen, instead of being ruptured, may be displaced and reversed in position by an injury which ruptures other abdominal viscera. Thus, in a boy, aged nineteen, who was brought into the Middlesex Hospital, the stomach, diaphragm, and left kidney were ruptured; the stomach, with its contents, and the left lobe of the liver, were projected upwards through the rent in the diaphragm, and the lower end of the spleen was dragged upwards with the stomach into the chest.

The *symptoms* of ruptured spleen are collapse, pallor, and coldness from loss of blood; præcordial pain, gasping and shortness of breath; small, feeble pulse, sometimes very quick, from 120 to 150 beats in the minute; vomiting, thirst, and retention of urine. In many cases it is not possible to say what proportion of the symptoms is due to the rupture of the spleen, as there is so frequently a complication with other injuries within the abdomen and chest. Slighter cases of rupture of the spleen are likely to give rise to intra-peritoneal abscess, more especially in the left hypochondrium, between the diaphragm, stomach, and spleen. .

Rupture of the Kidney.—It may be stated at once that hæmaturia following an injury to the loin, or lumbar region of the abdomen, is not necessarily symptomatic of ruptured kidney, and that on the other hand hæmaturia is not always a symptom when the kidney is ruptured; for the ureter may become completely plugged by clot, so that neither blood nor urine can get down to the bladder from the injured organ, and therefore no hæmaturia occur, and at the same time the kidney may be lost as an excreting organ.[5]

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[1] Recherches sur la Rupture Spontanée de la Rate (Arch. Gén. de Médecine, 1843 et 1844).

[2] Des Ruptures Spontanées de la Rate (Mém. de Chir. de Méd. et de Pharmacie Militaires, 1855). For these and numerous other references on the subject of ruptures of the abdominal viscera, see Dr. Otis's exhaustive Surgical History of the War of the Rebellion, vol. ii.

[3] Trans. Path. Soc. Lond., vol. xxi. p. 395.

[4] Ibid., vol. xxiv. p. 173.

[5] See Trans. Path. Soc. Lond., vol. xi. p. 140.

(1) Hæmaturia may denote simply *contusion of the kidney.* This I believe was proved by two cases in each of which a boy was run over by carriage wheels. In each case there was collapse and præcordial pain as well as pain in the affected loin. In one case there was no difficulty or pain in micturating throughout; in the other the catheter had to be used at first. In each case the urine was mixed with a large quantity of blood; in one the hæmaturia continued for three days, and in the other for four days. In neither case was there any contusion of the surface, nor any swelling in the loin. Both patients were well within a fortnight, though slight localized peritonitis occurred in one.

(2) An injury short of actual rupture of the pelvis of the kidney, or of the ureter, is that of *strain or laceration of the pelvis or ureter*, followed by adhesive inflammation and obliteration of the urinary duct. Hydronephrosis follows within a week or two, and leads to a tumor in the loin; and this after a succession of tappings may cease to refill, owing to the complete destruction of the secreting substance of the injured kidney. An illustrative case of this sort is described by Mr. Croft,[1] and Mr. Stanley's[2] case was an exactly similar one to Croft's, and not one of ruptured ureter, as it is so often quoted as being. In other cases the kidney, in the course of months or years, becomes converted into a number of abscess-sacs, and the ureter atrophies after becoming quite impervious.[3]

(3) *Rupture of the kidney* is by no means a very infrequent accident, despite the protected situation of the organ, and its envelope of fatty areolar tissue. Nor is it by any means necessarily fatal, as is proved by the instances in which the injury has been felt through an external wound, by others in which urine and blood have been discharged through the loin, and by the case of the officer described by Hennen,[4] in which the patient, who had been shot in the side, and afterwards suffered attacks of retention and urinous abscesses in the loin, completely recovered after a piece of cloth had been discharged through the urethra. Recovery may even follow complete division of the kidney and obliteration of the corresponding ureter. Such a case has been recorded in the London Pathological Society's Transactions,[5] the patient subsequently dying of granular disorganization of the other kidney.

It is largely due to the plugging of the renal bloodvessels, and to the capacity of the other kidney, if healthy, for doing compensatory work, that so many recoveries from contusion, laceration, rupture, and puncture of the kidney take place.

The two chief conditions upon which recovery depends are the escape of the peritoneum, and that of the large branches of the renal artery and vein. If, however, a large branch of the renal artery be torn, and death does not quickly follow from bleeding, the gradually increasing hemorrhage is likely to lead by pressure to sloughing of the peritoneum, which may have escaped the original injury.

The kidney may be ruptured in several fashions, like the liver and spleen: there may be several small surface-tears, or the organ may be completely torn through, either transversely or longitudinally. Notes of each of these varieties are before me. It is more than probable, however, that some of the cases which have been regarded as examples of recovery from ruptured kidney, were not really cases of rupture: for example, a lad aged fifteen years had been run over, and for three days suffered pain in the hypochondrium, and vomited at intervals. There was blood in the urine on and after the day of the accident, and on the fifth day a quantity of granular matter, with uric acid crystals, a little blood, and some casts, were voided in the urine. On the seventh day the urine was clear, and on the tenth the boy seemed well and continued so afterwards. In this case, though the organ must certainly have been severely contused, one cannot but suppose that recovery would have been less rapid if the kidney had been ruptured.

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[1] Trans. Clin. Soc., vol. xiv. p. 107.

[2] Med.-Chir. Trans., vol. xxvii.

[3] Mr. Haviland has recorded such a case. Trans. Path. Soc. Lond., vol. x. p. 209.

[4] Op. cit., p. 455.

[5] Trans. Path. Soc. Lond., vol. xi. p. 140.

After injury to the kidney or ureter, the symptoms are sometimes too obscure or insufficient for accurate diagnosis. In Stanley's[1] two cases, the urine was passed naturally and freely, and there were no symptoms leading to a suspicion of injury to either ureter or kidney, until a large tumor from which fluid containing urea was drawn away, formed in the right hypochondrium of one, and in the lumbar region of the other. In Poland's case,[2] which I had the opportunity of watching when Senior House Surgeon at Guy's Hospital, the precise nature of the injury remained doubtful up to the time of death, owing to the almost entire absence of urine during the six days the patient lived. The absence of urine was due to thrombosis of the renal vessels of one kidney, and the rupture of the pelvis of, and extravasation of urine from, the other kidney. Thrombosis of the renal vessels, as a result of violence to the lumbar region of the spinal column, is a possible occurrence, and should be remembered in relation to renal injuries, and to suppression of urine after injury to the back. Dr. Moxon[3] has described a typical sample of nearly complete obstruction of both kidneys, in a man aged twenty-two who was struck in the back by an engine.

If after the collapse from an abdominal injury has passed off, pain in the hypochondriac or lumbar region continues, and there is vomiting and anxiety of countenance—if moreover the urine contains blood and blood-casts gradually diminishing in quantity for from three or four to six or seven days or longer, and if convalescence is slow—the suspicion that some contusion or laceration has occurred is justly aroused. If after the abdomen has been run over, or the person has fallen or been struck on the abdomen or loin, faintness, coldness, vomiting, and abdominal pain follow; if on the day of, or the day after, the accident, and whether the catheter be required or not, the urine is found to contain a quantity of blood and blood-clot; and if after several days blood-clots continue to pass, or pus as well as blood is voided in the urine; if moreover there is pain along the course of the ureter, with retraction of the testis, or a rigid and prominent state of some of the muscles of one side of the abdomen, with frequent desire to micturate; or, finally, if a tumor, dull on percussion, forms in the loin, or lumbar or hypochondriac region of the abdomen, accompanied or not with signs of local peritonitis, there are safe grounds for believing that either the kidney or its pelvis has been ruptured. The passage of blood-clot along the ureter into the bladder, is a source sometimes of great suffering, and of cystitis. The clots frequently assume the shape of the pelvis of the kidney, sometimes they are long, worm-like casts which have been moulded in the ureter, and sometimes they are blood-casts of the uriniferous tubes. The latter are frequently seen if looked for after slight injuries, such as contusions of the kidney. If the bleeding is not excessive, these various clots cease to pass after a few days.

A typical and instructive case, the notes of which I took when dresser to the late Mr. Hilton, was made the subject of a valuable clinical lecture[4] by that philosophic surgeon:—

The case was that of a man aged twenty-one years, who was struck by the buffer of an engine. On admission, he vomited, and complained of great pain in the abdomen just

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[1] Med.-Chir. Trans., vol. xxvii.

[2] Guy's Hospital Reports, 3d series, vol. xiv.

[3] Ibid.

[4] Ibid., vol. xiii. p. 9.

beneath the ribs, which was aggravated on the slightest pressure; the next morning vomiting and pain continued, but he was able to walk to the closet where he passed both urine and feces. On the day following the injury the catheter had to be passed, and a pint and a half of bloody urine was withdrawn. Some improvement followed on the fourth and fifth days, but on the eighth there was an increased quantity of blood in the urine. From the fourteenth day till his death, clots of blood accumulated in the bladder, and, besides obstructing the flow of urine, gave rise to agonizing pain in the hypogastrium and at the end of the penis. The pain in the penis was much relieved at times by merely passing a catheter a few inches down the urethra. A dull swelling formed in the left side of the abdomen; tympanites and delirium supervened; and the patient died on the twenty-sixth day. The left kidney was found ruptured across the middle, and the lower segment cracked transversely by very numerous, minute fissures. The left ureter and a branch of the left renal artery, on which was a small, recent aneurism, opened into a large cavity surrounding the broken kidney, and filled with grumous and vilely offensive blood, clot, and urine. The renal vein was not injured. In the peritoneum forming the anterior wall of this cavity, there was a ragged rent in a thin slough, through which offensive, bloody serum was found to exude into the peritoneal sac. No positive evidence of peritonitis existed.

Mr. Cock has recorded[1] a case of rupture of a single kidney in a lad eighteen years old, who fell from a height on to some rafters. Collapse and left-side abdominal tenderness ensued; and the next day the pain had increased—being very severe indeed on the left side—and all the ordinary signs of peritonitis had set in. On the introduction of a catheter only a small quantity of blood passed. Within a few days all symptoms of the original injury and of the subsequent peritonitis had subsided, except that the catheter, which was regularly required, withdrew nothing but blood. On the subsidence of tympanites a tumor was observed on the left side, and the patient died comatose on the eleventh day. The left kidney was completely divided through its pelvis, and the two halves were widely separated by a collection of blood and urine, which had been extravasated into the cellular tissue on both sides of the spine behind the peritoneum, upwards as high as the diaphragm, and downwards, in connection with the left psoas muscle, to the thigh. One of the smaller branches of the renal artery was open in the cavity. The kidney and ureter were nearly twice the normal size, owing to the rudimental state of the right kidney, and the congenital absence of the upper part of the right ureter, vein, and artery. In this case there was a large rent in the diaphragm, and the liver and stomach were displaced into the left pleural cavity.

Rupture of the Ureter.—There is no occasion to consider this apart from rupture of the kidney, as in the few cases on record the rupture was quite close to the pelvis of that organ; this is only what might be expected, since, excepting near the kidney, the ureter is so placed as to be well nigh secure from all external violence. Moreover, it is neither practicable nor necessary to make a distinction between the two sets of cases, either as regards symptoms or treatment. Poland[2] has put together six cases of so-called injury of the ureter. Two of them were examples of bullet-wound and not of subparietal rupture; and in only one of these, namely, the case of the Archbishop of Paris,[3] in which the rupture was close to the pelvis of the kidney, was it certain that the ureter alone was injured; the other case is described by Hennen as a "complicated wound of the kidney," and, as the patient recovered, it is a gratuitous assumption on Poland's part to place it under wounds of the ureter. In two cases which I had the good fortune to follow from beginning to end, namely, Hilton's, and Poland's own, the kidney itself was ruptured; Hilton's ought not to be included at all in Poland's list, as it was not a case of rupture of the ureter, the kidney having been completely divided transversely across the pelvis, like some other cases on record;[4] in Poland's own case, in addition to the complete rupture of the ureter "just below the pelvis of the kidney," there was a rent in the back of the kidney, which had opened a branch of the renal vein and produced free bleeding beneath the investing fibrous capsule. One case reported by Stanley,[1] namely Vincent's, was not one of rupture of the ureter; a large irregular aperture was found in the pelvis of the kidney. Stanley's other[2] case ended in recovery, and the precise nature of the injury was therefore not ascertained; but there is nothing in the account of the case to point to the ureter, rather than to the kidney, and as rupture of the kidney is so much less rare than rupture of the ureter, the presumption is in favor of the former. Thus Poland's own case is the only one of the six in which there was a rupture of the ureter, as distinct from the pelvis of the kidney; it is, as far as I am aware, the only known case in which a subparietal rupture of the ureter has been proved. R. Harrison[3] briefly records a case of "rupture of the ureter quite close to the kidney," that is, of the pelvis of the kidney; no details of the autopsy are given, though it is stated that the patient died the next day. "Some blood-stained urine was removed by the catheter, but beyond this there was nothing requiring any special comment as indicating the full extent of the damage."

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[1] Trans. Path. Soc. Lond., vol. i. p. 293.

[2] Guy's Hosp. Reports, 3d series, vol. xiv.

[3] Gaz. des Hopitaux, 1848.

[4] See Taylor's Medical Jurisprudence.

The *prognosis* in rupture of the kidney, its pelvis, or ureter, is unfavorable, though less so than in rupture of the other abdominal organs. There are many cases published of recovery after injury, in which there is reason to believe that the kidney has been ruptured, and others in which healing has preceded death from other causes. The fatal result may be brought about early by collapse, hemorrhage, or peritonitis; or at a later date by pyæmia, cystitis, hectic fever, or exhaustion from abscesses excited by urinary extravasation, or by broken-down tissues or blood-clot; or death may occur from peritonitis or collapse set up by the bursting of the contents into the peritoneal cavity, through a sloughing of the limiting membrane of the abscess. If the ureter becomes permanently obliterated after injury, the kidney becomes destroyed, and death may be caused by suppuration of the organ. Injuries to the kidney, or to its pelvis, are likely to be complicated with injury to the peritoneum, or to be themselves complications of various kinds of fracture of the adjacent vertebræ.

Rupture of the Pancreas.—The pancreas is rarely ruptured. There are cases recorded by S. Cooper,[4] Le Gros Clark,[5] and Devergie;[6] and Travers[7] had under his charge, at St. Thomas's Hospital, a woman who when drunk was knocked down by the wheel of a stage coach, which did not pass over her. She lived a few hours; several ribs were fractured, the liver was lacerated, much blood had been effused, and the pancreas was completely torn through transversely. Ogston[8] has also recorded a case in which pieces of the pancreas, together with other organs, protruded through a lacerated wound of the parietes. In all these cases the rupture of the pancreas was associated with rupture of other internal organs, and in all death occurred within a few hours. It is impossible therefore to ascribe symptoms specially to the injury of the pancreas, and there is no case on record in which Benjamin Bell's[9] anticipation of what might happen from division of the pancreatic duct, has been realized, viz., greatly impaired digestion and intra-peritoneal collections of pancreatic juice requiring removal by the surgeon.

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[1] Med.-Chir. Trans., vol. xxvii.

[2] Ibid.

[3] Lectures on the Surgical Disorders of the Urinary Organs, p. 328.

[4] Lancet, Dec. 31, 1839, p. 486.

[5] Lectures on the Principles of Surgical Diagnosis, etc., p. 298. London, 1870.

[6] Méd. Légale, 2e éd., t. ii. p 94.

[7] Lancet, vol. xii. p. 384. 1827.

[8] Brit. and For. Med.-Chir. Review, vol. xxxix. 1867.

[9] System of Surgery, 7th ed., vol. ii. p. 147.

Treatment of Rupture of the Solid Viscera.—In all cases in which contusion or rupture of the solid viscera of the abdomen is suspected, absolute rest in bed must be observed; the administration of solids by the mouth must be avoided; and anodynes should be subcutaneously injected, to ease pain and allay restlessness and tossing about. The internal use of gallic acid, ergot, and iron, has been recommended to check hemorrhage, and should be tried; or little pieces of ice may be sucked. Pain will sometimes be assuaged by strapping the affected side, a practice which assists in keeping all the parts quiet, and which by gentle compression tends to limit and control hemorrhage. The bowels ought not to be disturbed for several days. Only fluids, and those only in small quantities at a time, should be allowed, for two or three weeks at least. In cases of injured kidney, this is very important; for fluids tend to increase the activity of the kidneys, and in Hilton's case above alluded to, the patient at his own earnest request was allowed a little solid food on the eighth day, from which time fresh hemorrhage occurred, and the case went rapidly from bad to worse. In all abdominal injuries in which hemorrhage is to be feared, and as little intestinal activity as possible is wanted, solid food of every sort is to be forbidden; for it stimulates the action of the heart, and gives the muscular coats of the bowel more to do.

If peritonitis occurs, it must be dealt with as directed elsewhere; if abscess forms, it should be opened and drained. In renal injuries, if prolonged and exhausting suppuration of the kidney occurs, the question of nephrectomy should be well considered; and, indeed, if the indications of ruptured kidney or pelvis are marked, and the gravity of the case great, nephrectomy will in future be probably adopted, as giving the best prospect of recovery. If clots accumulate in the bladder, or are forced into the urethra, and there give rise to such pain and distress as was witnessed in Mr. Hilton's patient, median urethrotomy, or lateral cystotomy if requisite, should be performed; the bladder could then be washed out, and the clots discharged through the wound in the perineum. I well remember this proceeding being discussed in the case referred to, and feel sure that it would have saved much suffering had it been performed.

Mr. Rawdon[1], of Liverpool, has recently put this treatment to the test of practice, though, unfortunately, at too late a period in the course of the case. If the blood-clots are very small, they can be voided through the urethra, and do not set up vesical disease; or they escape easily, after washing out the bladder through a full-sized catheter. When of larger size, the patient ought not to be deprived of the relief of a median perineal incision of the urethra, which should be followed up by a lateral incision of the prostate, if more room for escape is requisite.

RUPTURE OF THE GALL-BLADDER AND THE BILIARY DUCTS.—Rupture of the gall-bladder, or of the cystic, hepatic, or common bile-ducts, or of the biliary canals within the substance of the liver, may occur as the result of either external violence, such as a blow on the abdomen, or excessive dilatation from sclerosis of their coats, compression by new growths, impaction of calculi, or other pathological processes leading to ulceration or sloughing of their walls. There is the authority of Rokitansky for saying that the gall-bladder occasionally gives way by ulceration set up by gall-stones, and that death from peritonitis, due to extravasation of bile into the peritoneal cavity, is the result. Such a case, in which death followed three days after the rupture, is recorded in the London Pathological Society's Transactions,[2] and many others are to be found in pathological records.

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[1] Lancet, May 26, 1883.

[2] Trans. Path. Soc. Lond., vol. xix. p. 259.

Mr. John Freeland[1] (Government Medical Officer Antigua, West Indies) records the case of a black woman, aged sixty-five, who for many years had been troubled with intermittent fever, followed by a regular train of symptoms commencing with vomiting, colicky pains, and tenderness of the abdomen, and ending with jaundice, more or less severe. In one attack, in addition to the above symptoms, she was seized with excruciating pain in the stomach and chest, inability to retain anything swallowed, hot and dry skin, hurried pulse, tender abdomen, and death from collapse in about five days—after increased abdominal pain, tenderness and vomiting, and rapidity and failure of pulse. At the autopsy, the abdomen was found literally filled with blood and bile; the intestines were gangrenous in spots; the peritoneum everywhere inflamed, and with adhesions; the liver and gall-bladder healthy, the latter empty and smaller than normal; the spleen stained indelibly throughout with bile; the hepatic duct recently ruptured; the calibre of the duct much smaller, and its length greater than usual. In some places the duct was pouched, and the pouches contained gall-stones of size varying from that of a pea to that of a strawberry. In one of these pouches was a large slit, with firm edges, and completely plugged by the accurately-fitting end of a biliary calculus, which by pressure had caused the ulceration. The second or recent rupture was the cause of death; the older one had existed for years, and had always been occupied and closed by the gallstone, except occasionally when some exertion displaced it temporarily and allowed the bile to escape. These occasional extravasations led to the intermittent attacks; the final and most severe one was set up by the recent rupture.

Rupture of the smaller biliary canals, followed by extravasation of bile into the liver, repeatedly occurs in cases of retention of bile; and extravasation of bile from the same canals follows laceration of the liver, whether the peritoneal coat be torn or not; but the significance of the extravasation of bile in these cases is submerged in that of the general injury of the liver. Rupture of the gall-bladder, or of the biliary ducts beyond the liver-substance, is apt to be followed by speedy death from peritonitis, owing to the escape of large quantities of bile into the cavity of the peritoneum. From experiments on animals, as well as from what is occasionally seen after accident or operation in man, the fatal termination is probably brought about, not so much by the sudden escape of bile into the peritoneum, as by the continual pouring out of fresh quantities into the peritoneal sac. There are a few cases on record which prove that, if the continued escape of bile into the general cavity of the peritoneum be prevented, recovery from rupture of the gall-bladder or of a large bile-duct may take place. Provided that the effusion of bile is at first slow, so that there is time for adhesions to form a cyst-like chamber, shut off from the general peritoneal cavity, large quantities, even two or three gallons, of bilious fluid may accumulate outside the biliary passages and form a large tumor in the right hypochondrium, pushing up the diaphragm and lung, and causing a prominence of the anterior abdominal parietes, over the region of the liver. Such was the condition in Skeete's,[2] Fryer's,[3] and Barlow's[4] cases, the latter two of which ended in recovery. In each of these cases repeated tappings, at intervals of about ten days, led to the withdrawal of as many as six or seven quarts of fluid. The fluid removed in Mr. Barlow's case was examined by Dr. Owen Rees and Mr. Thomas Taylor, and was found to be "full of bile." Dr. Rees estimated that it contained eight-tenths of bile and two-tenths of foreign matter. For a time after the accident, the feces in Fryer's and Barlow's cases were white, but as soon as bile began again to pass by the bowel the cysts ceased to refill, and the patients returned to a state of perfect health.

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[1] Lancet, May 6, 1882, p. 731.

[2] London Medical Journal, vol. vi. p. 274. 1785.

[3] A Case of Extravasation of Bile into the Cavity of the Abdomen. Med.-Chir. Transactions, vol. iv. p. 330.

[4] Ibid., vol. xxvii. p. 378.

There is little room to doubt that in these cases either the gall-bladder or one of the biliary ducts was ruptured, that for a time all the bile secreted was poured into a cavity formed by inflammatory adhesions, and that ultimately the proper channel became re-established. This favorable termination seems to me to be explained by the light of Sir Benjamin Brodie's experiments on ligature of the ductus choledochus. He found that the pressure of the ligature on the bile-duct was unlike in its effects to that on an artery or vein; that it did not cause adhesion of the apposed surfaces; but that a mass of organizable lymph was effused, and adhered to the duct above and below the seat of ligature, as well as to the surrounding parts. Thus a cavity was formed in which lay loosely the ligature which had been detached by ulceration of the duct. Into this cavity the bile could be made to flow from the orifice above, and out of it by the orifice below the point of ulceration, so that, though the continuity of the biliary duct was destroyed, a good bile-passage was restored. Sir Benjamin Brodie remarks that the same thing happened when two ligatures had been applied at some distance from each other on the common duct. Tiedemann and Gmelin obtained similar results on dogs; in their experiments the bile-passage was re-established in a period varying from thirteen to twenty-six days after the ligature was applied.

The gall-bladder may be completely torn away from all its connections, without immediate death being caused, and without the escape of its contents:—

Dr. Francis Ogston,[1] of Aberdeen, has recorded the case of a man whose belly was forcibly knelt upon. The gall-bladder was found, full of bile, lying loosely in the abdomen near the umbilicus, in front of the small intestines, having been broken away from the cystic duct close to its origin. A thin piece of the liver, one inch in breadth and corresponding to the cystic hollow, was firmly adherent to the surface of the gall-bladder. The patient died on the third day after the accident, from hemorrhage, ten pounds of blood being in the peritoneal cavity. Ogston records a second case, in which the gall-bladder was torn away with part of the liver, in a very similar manner; but in this instance the injured viscera protruded through a wound in the abdominal parietes, and death was instantaneous.

In Dr. Walter Fergus's[2] well-known case, the gall-bladder was ruptured above, opposite the junction of the hepatic with the cystic duct, and the liver was also lacerated; yet the patient was so well on the fifth day after the accident that he was considered convalescent, and allowed to get up; two days subsequently he was suddenly seized with the symptoms of acute peritonitis, and died on the ninth day. At the autopsy, the gall-bladder was found empty, the peritoneal cavity contained a large quantity of bile, and peritonitis was general. The wound in the liver was undergoing repair, and it is possible that, had absolute rest been enjoined for a longer period, extravasation of bile might have been prevented by adhesions, and recovery might have ensued.

The commonest seat of rupture of the bile-organs would seem to be some part of the cystic duct. Poland[3] and Wolff[4] have recorded cases of rupture of the common bile-duct, and M. Campaignac[5] a case of longitudinal rupture of the left branch of the hepatic duct; while Bryant gives, on the authority of Dr. Sutton, of the London Hospital, a case of transverse rupture of the hepatic duct, one-quarter inch above its junction with the cystic duct. When the gall-bladder is filled with gall-stones, a blow over it is very prone to cause its rupture. Hoffman relates the case of a farmer's wife who was killed by a blow from her husband in the left hypochondrium. The gall-bladder was filled with calculi and freely torn. He also cites another similar case of a woman who was killed by a blow from a stick. Dr. Maclachan[6] gives the case of an old man who fell on the floor in getting out of bed, and died in forty-eight hours from peritonitis. The gall-bladder was ruptured, and a large stone was found impacted in the cystic duct.

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[1] Brit. and For. Med.-Chir. Review, vol. xxxix. p. 193.

[2] Med.-Chir. Trans., vol. xxxi. p. 47.

[3] Fothergillian Prize Essay.

[4] Gaz. Méd., 1830.

[5] Journal Hebdom., t. ii. p. 210. 1829.

[6] Med. Gaz., vol. xxxvii. p. 968.

The *symptoms* of rupture of these organs, if uncomplicated by injury to other viscera, depend on whether the extravasation takes place into the peritoneal cavity, or into a space surrounded by adhesions. If no extravasation occurs, the only symptoms may be more or less collapse, with some abdominal pain, vomiting, and dyspnœa; and these may soon pass off. If the bile escapes into the general peritoneal cavity, the symptoms of acute peritonitis will set in. John Bell says, "I saw a man die in a very miserable condition, who had, by a fall, torn the gall-ducts, so that the abdomen swelled with dreadful pain; the most thorough jaundice I ever saw; and the abdomen, when opened, was full of bile, serum, and coagulated lymph, the intestines universally tinged of a yellow color, universally inflamed, adhering at some points and gangrened in others."[1] If the bile escape into a space circumscribed by adhesions, there will be the symptoms of acute, localized peritonitis, and jaundice; at a later period a tumor will be formed in the hypochondrium, as in the cases above referred to; and if the whole of the bile be extravasated into this cyst-like space, the stools will be white. The time at which the bile escapes varies: in Dr. Fergus's case this occurred on the seventh day; in Ogston's, in fifteen hours; whilst in others it was at the moment of the accident. If the gall-bladder itself gives way, the bile is generally poured out in large quantity, and death follows immediately. Leseure[2] mentions five cases, in four of which death was instant; the fifth case was that of a child, aged twelve years, who lived till the fourth day. In Sutton's case of rupture of the hepatic duct, the abdominal pain appears to have slowly increased from the time of injury; jaundice and great abdominal distension supervened after some days, and death occurred on the thirty-eighth day. Jaundice is, probbly, the effect of shock, though it may be the result of obstruction at the seat of injury.

Treatment.—In any case where there is reason to suspect that the gall-bladder is injured, or the bile-ducts torn, the greatest quietude should be observed, so as to prevent, if possible, the extravasation of bile, and to give time for the surrounding of the wounded part by organizable lymph. The cases quoted prove that the bile is not always poured out at once; and if straining by vomiting, the use of purgatives, and active movements of every part and organ of the body be avoided for a few weeks, there will be plausible grounds for hoping that recovery may take place. Absolute rest in bed, warm fomentations to allay pain, and the application of leeches over the seat of injury, should be resorted to; a little ice may be sucked from time to time to check sickness and allay thirst; and as little food as possible, and that only of a liquid nature, should be given. If after several days it should become necessary to relieve the bowels, enemata, not purgatives, should be employed. If a tumor forms, the extravasated bile should be evacuated as often as need be by the trocar and canula. Fryer's and Barlow's cases show that success sometimes attends this practice. Laparotomy, followed up by suture or removal of the gall-bladder, ought, in certain cases, to be adopted.

RUPTURE OF THE THORACIC DUCT.—Next to nothing is known of this occurrence, either as a distinct injury or as a complication of other abdominal ruptures. It is difficult to suppose that such an accident as simple traumatic rupture of the thoracic duct without an external wound could occur; but if it happened, and life were prolonged for any number of days afterwards, the physiological purposes of the duct suggest what the symptoms would be, viz., those of inanition, owing to the whole or greater part of the blood-forming fluid derived from the digestion of food being perverted from its natural channel. One would not expect that the extravasation of lymph would be quickly fatal, but it is conjectural how far surgical relief could be afforded, even if the extravasated fluid should become encysted, either behind or within the peritoneal cavity. Rupture after dilatation of the thoracic duct by the pressure of some extrinsic growth, or from some intrinsic cause such as chalky or cheesy concretions in the duct, is a recognized contingency.

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[1] Discourses on the Nature and Cure of Wounds, 3d ed., p. 358.

[2] Sur les Ruptures et les Perforations de la Vesicule Biliaire. Paris, 1824. (An inaugural dissertation.)

RUPTURE OF THE PERITONEUM.—The parietal peritoneum, the peritoneum covering the mesentery or omentum, or the visceral peritoneum of any of the solid or hollow organs, may be ruptured without injury to the muscles of the parietes or to the abdominal viscera. Such an accident is rare as the result of a blow or other form of external violence, but it is not so very infrequent in the case of the peritoneum covering the uterus, or as a result of over-distension of the stomach or intestine. The two chief dangers of rupture of either parietal or visceral layers of the peritoneum are peritonitis and hemorrhage. The symptoms, treatment, and results of contusions of the abdomen followed by intra-peritoneal hemorrhage, have been already described. We now pass to the consideration of traumatic peritonitis.

TRAUMATIC PERITONITIS.

Causes.—Inflammation of the peritoneum is caused by injury either from without or from within the abdomen. From without, the causes are contusions, ruptures, and wounds of the abdominal parietes. From within, peritonitis may be started by the giving way of hydatid, ovarian, or other cysts, by perforation from disease of the hollow viscera, or by the bursting of an intra-abdominal abscess; the penetration of the gut by intestinal worms has also been known as the origin of fatal peritonitis.

Though all these causes are in a sense traumatic, the name Traumatic Peritonitis is generally applied only to inflammation started by some blow or other external violence, and then, whether the abdominal parietes are injured or not, and whether the peritonitis arises directly from the injury, or by extension of inflammation from some other structure of the abdominal parietes or contents to the peritoneum. Though our experience of to-day has proved the peritoneum to be tolerant of an amount of interference which not many years back would have been regarded as quite incredible, still it is even now equally true that very slight wounds of the peritoneum may lead to peritonitis, if foreign bodies or septic materials be introduced from without, or escape from the viscera within, or if the persons upon whom such wounds are inflicted be in an unhealthy condition. In such cases, however, though the wound is the exciting cause, it is these associated phenomena, and not the wound itself, which are most conducive to the peritonitis.

Varieties.—Traumatic peritonitis is always more or less acute, and may be either local or general. Although it is apt to spread rapidly over the greater part or the whole of the membrane, it is not unfrequently limited to the immediate neighborhood of the injury. Commonly the form of inflammation is the sthenic; but if it occurs in a feeble, unhealthy subject, it is likely to assume the asthenic or puriform character. If due to the introduction of poisonous or decomposing material, the peritonitis will certainly take a septic form.

Symptoms.—These usually show themselves in from six to thirty-six hours after the injury, and then develop very rapidly. In some cases of injury, and especially after the rupture of any of the abdominal organs, the onset of the symptoms is immediate, or nearly so. In other cases some days may elapse between the receipt of the injury and the first indication of peritonitis. The invasion of the inflammation may be masked or retarded by the collapse following the injury, but as soon as reaction has set in, the local and general symptoms become thoroughly pronounced.

Of the local symptoms pain is the earliest, and the most striking and severe. It is sometimes excruciating and unbearable, and may be preceded by a rigor. Commencing at the seat of injury, it may spread over a larger and larger area, until perhaps it pervades the whole abdomen. Pressure, movement of every kind, the acts of vomiting, defecation, and micturition, intensify it. In order to lessen the pain as much as possible, abdominal respiration ceases, and tension on the abdominal walls is sought to be relieved by posture; hence the patient lies on his back with the thighs and knees flexed, and sometimes the hands and arms are used to protect the belly from the weight of the bedclothes. The pain is variously described as hot, burning, stabbing, or cutting; and from time to time it is increased by paroxysms of greater intensity, due to the vermicular or spasmodic contraction of the intestines. In exceptional cases the pain is but moderate, and it may be absent altogether.

Vomiting is an early and a troublesome symptom, and occurs both spontaneously and as an effect of taking anything by the mouth. At first the vomited matter consists of the contents of the stomach and upper part of the intestine, then it becomes of a greenish or dirty brown and watery character, very bitter to the taste; and at a later stage it is occasionally feculent. Eructations and hiccough are not uncommon, and are sometimes distressing; constipation and gaseous distension of the bowels, owing to the palsied, softened, and œdematous state of the intestinal coats, is the general rule. With the tympanites are sometimes associated feeble peristaltic movements; and rumbling or gurgling sounds, or borborygmi, may be heard. The abdominal distension varies, both in degree and in rate of increase, being most marked, as a rule, in persons with feeble or lax abdominal parietes. Before the distension occurs, the muscles of the abdominal walls are retracted, hard, and rigidly contracted, and even after they become paralyzed, the abdominal walls are still very tense, owing to the rapid increase in the distension of the stomach and intestines. The urine is high colored and loaded with urates, is passed very frequently, and causes scalding. At a later stage, retention supervenes from palsy of the muscular coats of the bladder. The respiration is quick, shallow, and entirely thoracic, not diaphragmatic nor abdominal. The irritation of the vaso-motor nerves is excessive, owing to the large area over which they are frequently involved in this disease; and this irritation produces a great effect upon the heart. The pulse is small, reaching 120–160, wiry, non-dicrotic, or very slightly dicrotic; and the arteries, even the very small ones, are contracted. The heart is not, however, stimulated thereby to strong, slow contractions, in order to overcome this resistance to the free flow in the vessels, but beats slowly and feebly. Except as regards rapidity of pulse, the state of the circulation differs widely from that which is usual in fever.[1] The pulse has usually a good pressure, but it may after a time become compressible, and yet, owing to the feebleness of the heart's action rather than to high arterial tension, it will remain non-dicrotic. A dicrotic pulse in peritonitis indicates some complication in the disease. The feeble state of the heart, and the cough, hiccough, and shallow respirations, are also largely due to the direct effect of the tension on the diaphragm and thoracic viscera by the great gaseous accumulation within the abdomen. Intestinal movements are seen through the tense abdominal walls; to the hand, the abdomen is smooth and regular, and though in the earlier stages the muscles contract on palpation, at a later stage the belly feels simply drumlike, and the normal hepatic and splenic dulness is completely lost. The amount of fever, as indicated by the temperature chart, varies greatly. As a rule, the temperature rises rapidly in the early stage, and continues high for a day or two; it has, however, no regular course, and remissions are not infrequent. In the asthenic form of acute peritonitis, the temperature may not rise at all, or may be even below normal. Indeed, in many cases after operation for hernia or ovariotomy, and in general blood-poisoning, all the symptoms of peritonitis are masked. Patients rapidly sink and die from peritonitis under such circumstances without complaining of abdominal pain, or evincing any of the characteristic local symptoms of the disease, except steadily increasing tympanites. In such cases, it is the increasing rate and diminishing volume of the pulse, the pinched features, restlessness, and cold, clammy skin, which warn the surgeon of the fate which has overtaken his patient.

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[1] See Galabin, On the State of the Circulation in Acute Diseases. Guy's Hosp. Rep., 3d series, vol. xix.

The appetite in traumatic peritonitis is lost, thirst is intense, the tongue is furred at the sides, and red, or brown, or dry at the centre, and a sensation of heat at the epigastrium is often complained of. The patient becomes very uneasy and restless, and whilst keeping the trunk steady, tosses the arms and hands incessantly outside the bedclothes. The hands and feet are hot and burning, so that the patient begs to have them frequently moistened, and will hold in each hand a cold, damp cloth, which he often desires to have wetted. The countenance soon becomes expressive of pain and anxiety; the features look sunken, pinched, and withered; dark areolæ surround the orbits, and there is extreme prostration of strength, though the intellect remains clear, and delirium is rare. Occasionally, more especially if the intensity of the inflammation spends itself in the neighborhood of the liver and bile-apparatus, jaundice occurs. In exceptional instances, a considerable amount of ascites exists, and fluctuation is present. Rarely, delirium is a prominent and early symptom. High fever, the passage of bloody stools or blood-stained vomit, incessant hiccough, diarrhœa, albuminuria, and very urgent dyspnœa from extreme tympanites, are also occasionally witnessed.

Diagnosis.—This is usually easy, but some painful conditions of the abdominal wall following an injury may be mistaken for traumatic peritonitis. Thus cutaneous hyperæsthesia, localized inflammation, or even rheumatic affections of the muscular and aponeurotic structures of the parietes have led to error, especially when occurring in nervous or hysterical subjects, and when abdominal distension, sickness, and constipation have been associated with the local symptoms. With proper care, however, such conditions will readily be distinguished from peritonitis. Localized inflammation, commencing as the result of an injury in the areolar tissue of the pelvis or loins, or around the kidney, cæcum, or bladder, may lead to the suspicion of peritonitis; but such diseases are prone to involve the peritoneum, and it cannot be positively asserted, under the circumstances, that this membrane is not inflamed; and the peritonitis once started tends rapidly to become general. Cramp in the stomach, intestinal colic, and other painful abdominal affections, if accompanied by vomiting, rapid pulse, and a tendency to collapse, might be mistaken for peritonitis, though the history, mode of onset, and relief of pain by pressure, ought to clear up any doubts.

Prognosis.—The more localized the peritonitis, the more hopeful the result; the more rapid the symptoms, the graver the case. When the peritonitis is the result of direct injury limited to the peritoneum or parietes, the prognosis is more favorable than when it arises under other circumstances. When due to rupture or perforation of the viscera, or excited by septic poison, death is almost certain. In most cases the fatal termination occurs within a week or ten days, or less. Sometimes death takes place during the height of the attendant fever; but more frequently the mode of death is by asthenia, the respiration and heart's action becoming more and more feeble, until fatal collapse supervenes. Pain and even tympanites then become less marked; the temperature falls below normal; the extremities feel cold and turn blue; the skin is clammy and unnatural to the touch; the pulse flickering, irregular, and too fast to count; the respiration is hurried, jerky, and sighing; the voice weak and whispering; and the expression one of helpless and imploring anxiety. Sometimes before, at, or immediately after death, a quantity of dark coloured fluid flows freely through the mouth and nose.

Occasionally the acute symptoms of traumatic peritonitis subside, but leave the patient ill, with an abnormal temperature, great debility, and some localized collection of inflammatory fluid; this, after a variable time of further suffering, may burst, and, forming a communication with some hollow organ, recovery may afterwards ensue, or, on the other hand, death may occur from pyæmia, septicæmia, or exhaustion. In mild cases of traumatic peritonitis, or if the inflammation be limited in extent, or the inflammatory products fibrinous or sero-fibrinous, or if the patient be young and of vigorous constitution, and judicious treatment have been adopted at an early period, recovery may take place; but death may occur at any period after recovery from acute peritonitis, from the effects of adhesions or bands, the products of the inflammation. Constipation and complete intestinal obstruction are common consequences of these inflammatory adhesions.

Treatment.—In the treatment of acute, traumatic, as well as of other forms of acute peritonitis, it seems superfluous to enjoin absolute rest of the abdominal muscles, and perfect freedom from weight and pressure upon them, because the feelings of the patient will secure attention to these points, and nature herself does much to compass them. The application of leeches to the abdomen, as soon as pain sets in, followed by hot fomentations frequently applied, is the best local treatment. As many as twenty to thirty leeches, or more, may be used, if the patient be of a robust and healthy constitution. Local bleeding is much to be preferred to venesection, in peritonitis; but it is only of service in the early stages of the disease, and is not to be employed at all in the asthenic forms, such as occur after operations for hernia, ovariotomy, and other abdominal operations. With the hot fomentations may be used the extract of conium, belladonna, or opium; or turpentine stupes may be employed; cold compresses, or flannels wrung out of ice-cold water have been advocated, instead of hot applications, and perhaps, in the early stage of acute peritonitis, a more extended trial will prove their worth; pain and nervous and intestinal irritability are said to be allayed by cold, and certainly the bloodvessels of the inflamed parts are contracted by it; but the sensations of the patient must in part guide the surgeon in the employment of cold as a remedy. In the later stages cold applications are out of the question, and hot should be used; at a still later period, blisters, iodine, or mercurial preparations are sometimes useful in promoting the absorption of inflammatory products.

The best internal remedy is opium, given in half or one grain doses every three or four hours: it allays pain, diminishes reflex irritation, and quiets the action of the stomach and intestines. It may be administered by the mouth or rectum; or morphia may be subcutaneously injected instead. In children, and in persons afflicted with renal disease, opium and morphia must, however, be employed with great care. In young subjects, and when the peritonitis is of the sthenic form, calomel, in one grain doses, combined with opium, and given until the system is brought under its influence, is often of great benefit; in some cases it will be found to afford great relief from meteorism. Nausea and vomiting are best combated by sucking small pieces of ice, or by taking small quantities of iced, effervescing drinks, with hydrocyanic acid in small doses. Sometimes the subcutaneous injection of morphia has the effect of checking sickness. Constipation should be left without treatment for some days, and then enemata are the best aperients. For the first thirty-six or forty-eight hours, no food beyond a little iced milk need be given, then thick beef-tea or essence of meat, in teaspoonfuls at a time, at intervals of fifteen or twenty minutes should be taken. If the stomach rejects all food, an enema of two ounces of beef-tea, with half an egg, should be given every five or six hours. If there is great exhaustion or depression, wine or brandy should be allowed. After the first week a more liberal diet—still, however, to be taken in small quantities at short intervals—may be permitted. During the whole period of convalescence, much care is requisite in feeding, in securing regularity of the bowels, and in avoiding all undue action of the abdominal muscles.

In all cases, after any injury to the abdomen, absolute rest should be enforced: rest by position, and the mental and physical quietude to be obtained by opium, will often prevent the occurrence of peritonitis, and will limit and subdue it when once set in. The surgeon every now and again sees a case of severe local peritonitis which has been caused by, though it has commenced some days after, a hurt to which but little if any attention has been given; and it is fair to presume that the patient would have escaped the inflammation if he had but taken proper precautions for a few days after the reception of the injury.

Wounds of the Abdomen.

Wounds of the abdomen are usually classified as "non-penetrating," that is, wounds of the parietes without perforation of the peritoneum; and "penetrating," that is, wounds involving the cavity of the peritoneum. The non-penetrating wounds in certain regions of the abdomen, such as the lumbar and hypogastric, may be complicated by protruding or wounded viscera, without implication of the peritoneum. The surgeon not unfrequently designedly inflicts such wounds, as when he performs colotomy or nephrolithotomy, or simply explores the kidney; or, again, as when for the relief of retention of urine he perforates the distended bladder above the pubis. That these wounds are not very dangerous, may be learned from the large success which results from these operations.

Penetrating wounds may or may not be complicated with injury, protrusion, or both injury and protrusion, of the viscera; but whether they are so or not, they are as a class much more serious than non-penetrating wounds. And yet there is nothing necessarily dangerous in the simple wound of the peritoneum, as the numerous operations practised on the abdominal cavity, and the varied and successful extension of such operations, amply prove. They are the accompanying circumstances, such as shock, neglect of surgical treatment for some hours after the accident, the bruising and wounding of the abdominal contents, and the escape of noxious fluids into the cavity of the peritoneum, which are the causes of danger in penetrating wounds.

Both the penetrating and the non-penetrating wounds vary according to the nature of the wounding body, and the mode of infliction of the injury. They may be either incised, punctured, lacerated, contused, or gunshot wounds. The incised are the simplest and most favorable; the punctured, if we except operation wounds, are the most common; the lacerated and contused are the most tedious in recovery, and the most prone to be followed by suppuration and sloughing; and gunshot wounds are the most fatal.

I. Non-Penetrating Wounds of the Abdomen.

Wounds of the same class differ from one another according to their extent and depth; their direction, in relation to the course of muscular fibres, blood-vessels, and nerves, and the natural folds or lines of the surface; their situation, with respect to the varying thickness of the parietes; and their form, as to whether they are linear, irregular, jagged, angular, or flap-like.

Incised wounds are produced by knives, razors, scythes, hatchets, sabres, pieces of tin, glass, or any other sharp-edged or cutting bodies.

Symptoms.—They are always followed by more or less gaping of the divided tissues, the degree of which depends upon the elasticity of the tissues, upon the tension of the abdominal walls at the time of, or subsequent to, the injury, and upon whether the wound is transverse to, or parallel with, the fibres of the muscles. The amount of bleeding will depend upon the size and number of the vessels wounded, but usually it is not severe; the pain which follows, is due first of all to the division, injury, or exposure of the nerve-fibres, and afterwards to the pressure of inflammatory effusion. Superficial or tegumentary wounds are less severe in their symptoms and in the risk of complications, and their treatment is more simple than that of the deep or musculo-tegumentary. There is scarcely any bleeding, and little or no difficulty in maintaining the edges together, in the superficial wounds; but, owing to the great thickness of the integuments in the loins, and to the prominence of the ribs at the epigastrium, sutures are almost always requisite in those situations. Sutures are also, as a rule, beneficial, though not necessary, elsewhere. In the hypochondria and epigastrium, the mobility of the ribs may require restraining in order to prevent traction on the sutures. Where the integuments are very thick, a wound may extend for some depth without reaching the muscles. In deep wounds, much depends on the division of muscles. In the epigastric, umbilical, and hypogastric regions, a transverse wound gapes widely, and possibly hemorrhage is severe from branches of the internal mammary or deep epigastric arteries, or some of the larger veins here situated. In the hypochondria, if the intercostal spaces are penetrated, troublesome bleeding may occur from the intercostal vessels. In the loins, the erector spinæ and even the quadratus muscles, as well as the posterior parts of the flat muscles and the lumbar arteries and veins, and branches of the spinal nerves, may be divided. Poland has pointed out that, if the external oblique muscle is wounded parallel to its fibres, and the internal oblique and transversalis are also divided, there is a liability for the blood and other discharges to collect instead of escaping, owing to the closure of the incision in the external oblique. In the iliac region, longitudinal wounds gape more than the transverse; here, too, there is a probability of the spermatic cord or the deep epigastric artery being wounded.

Treatment.—In the treatment of incised wounds, it is necessary, here as elsewhere, to restrain hemorrhage; to remove all dirt, pieces of clothing, or other foreign bodies; to provide for drainage; and to procure union of the divided edges.

(1) If the bleeding comes from some quite small vessels, or capillaries, and is of the character of oozing, exposure to the air for a short time will suffice; if from a vessel of larger size, such as the superficial circumflex iliac, or superficial epigastric, or a large muscular branch, a twist or two with pressure-forceps, or a ligature, will be required. If the hemorrhage be profuse or persistent, and its source a deep artery or vein, the wound must be enlarged, if requisite, to secure the bleeding ends. In bleeding from the deep epigastric, circumflex iliac, mammary, or lumbar arteries, there is danger in trusting to palliative measures. Many cases might be quoted to illustrate the fatal consequences of temporizing with compresses, binders, and styptics. The ligature, or torsion, is necessary, and in such cases the best anatomist will often prove the safest surgeon. Secondary hemorrhage is likely to occur from coughing, vomiting, or other form of straining, if the bleeding be only temporarily checked by coagulum. Compresses, graduated or otherwise, are not to be recommended: they cannot be well borne; they are often ineffectual, because there is no counter-resistance; and they are liable to cause burrowing of blood amongst the tissues, and in deep wounds to press away the peritoneum from the rest of the parietes.

(2) In the loin, in consequence of the great depth of the parietes, a foreign body may be lost from sight in the wound, and therefore not be detected; elsewhere there is not much chance of its escaping the scrutiny of a careful surgeon. Unless there be ground for suspecting the presence of an extraneous substance, probing should not be resorted to in abdominal wounds. The most scrupulous cleanliness must be observed in the dressings, and it is well to begin by washing the wound with some antiseptic solution.

(3) When there is blood in the wound, or a probability of oozing, a drainage-tube, or a twist of catgut, horse-hair, or oiled silk, should be inserted at one end of the incision.

(4) To bring the edges into apposition, and keep them there without tension, mobility, or irritation, it is well, in addition to sutures, to support the parts by long strips of adhesive plaster, well applied, so as to get a good hold of the tissues, and prevent them moving in respiration or in changes of position. Posture, too, is a great adjunct in securing the contact of the edges and keeping them at rest by relaxing the muscles. Thus, in transverse wounds in front of the abdomen, the trunk and thighs should be kept flexed; in transverse wounds of the lateral part of the belly, the trunk should be inclined towards the injured side; in wounds behind, and in longitudinal wounds elsewhere, the straight, recumbent posture should be kept. Whatever form of dressing be employed, it is always well to give support to the wounded part by applying it so that a gentle, elastic compression shall be exercised. This is easily done by placing a pad of cotton-wool beneath the retaining bandage.

There has existed a good deal of difference of opinion as to the use of sutures, but, with all deference for the teaching of Mr. Guthrie and others, it is my opinion that, though not always necessary in superficial wounds, they are advantageous in deeper ones. The interrupted suture is the best form; and the best materials are fishing-gut, catgut, or silk which has been properly prepared in a solution of melted white wax, carbolic acid, and chloroform. The sutures should be passed through all the divided tissues, muscle as well as fasciæ and skin, and should be inserted sufficiently wide of the cut edges to avoid their ulcerating or tearing through, before a bond of plastic material has been formed.

A restricted diet, gentle laxatives if the bowels are constipated, and opium if there be restlessness or pain, should be given.

In the majority of cases, incised wounds of the abdomen heal by primary adhesion if the above points of treatment have been attended to, and if the health, habits, and temperament of the individual are such as to favor quick and good repair. In other cases, healing takes place by the process of granulation in one of its various forms.[1]

Punctured wounds are produced by spikes, nails, needles, daggers, bayonets, lancets, foils, swords, the horns of animals, splinters of wood, and other such like things. The wounds for the most part correspond in size and shape to the instruments by which they are inflicted; those that are caused by sharp weapons approach in character to incised wounds, whilst those that are caused by blunt instruments resemble contused wounds; in other words, sharp bodies perforate tissues by cutting, blunt ones by crushing or tearing. Punctured wounds are sometimes called "perforated," but in the case of the abdomen it must be remembered that they are not necessarily "penetrating" in the sense of perforating the peritoneum.

In punctured wounds, the tissues may be transfixed obliquely or at right angles; they are usually somewhat smaller than the inflicting body, but of the same general shape. They are but rarely followed by much, if any, bleeding; as a rule the vessels escape or are pushed aside, and, even if they are wounded, the blood is poured out into the subcutaneous or inter-muscular tissues, and ecchymosis appears at a longer or shorter time after the injury. If an artery be wounded, a false aneurism may form; if both an artery and vein, an arterio-venous or varicose aneurism may follow. If a nerve or one of its filaments be injured, there will be immediate pain; and unless it be completely divided, it may give rise to prolonged suffering over the whole area in which the nerve-trunk is distributed. At a later period, pain will be excited by the pressure of effused blood or of inflammatory fluids. If the wound be deep, severe consequences are likely to follow, such as traumatic peritonitis; inflammation or suppuration in the different layers of the abdominal walls, which frequently simulate, even when they do not cause, peritonitis; cutaneous or cellulo-cutaneous erysipelas; septicæmia, pyæmia, and death. Inflammation is a frequent consequence of punctured wounds, and will almost certainly follow when they have been inflicted by a rusty, dirty, or blunt instrument. It spends itself chiefly on the deeper structures, and is prone to run on into suppuration, the symptoms attending which are sometimes of a typhoid character, and then not rarely prove fatal. When inflammation occurs, the wound swells, becomes red, painful, throbbing, hard, and tender, and ceases to discharge if it has previously done so; the pulse and temperature rise; the abdomen swells, grows hard and tense; coughing and perhaps even quiet respiration is painful; rigors usher in suppuration; cold, hot, and sweating stages, like ague, may repeat themselves; vomiting follows, and hiccough, cold sweats, great restlessness and sickening exhaustion precede death. Except in the superficial tissues, where fluctuation can easily be made out, the presence of pus can only be surmised by the constitutional symptoms, and by local fulness, hardness, and tenderness. The pus may burrow amongst the muscles widely, and when suppuration occurs behind the rectus, it may spread from xiphoid to pubis, without pointing or giving a distinct sense of fluctuation. Sometimes the matter points a long distance from the wound, as in the case of a soldier who, as related by Petit,[2] was wounded by a sword a little below the xiphoid cartilage; fluid pointed after several days, and was let out through an incision, one inch above the right abdominal ring. In other cases the matter spontaneously discharges itself through the original wound. In mild cases the inflammation or suppuration may be limited to the immediate area of the wound, the constitutional symptoms being proportionately less severe; and convalescence sets in as soon as a free opening allows of the escape of matter.

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[1] See Article on Wounds, Vol. II. pp. 18, 19, *supra.*

[2] Quoted by Guthrie.

Treatment.—The treatment is the same as for incised wounds. If hemorrhage is severe, or if there is reason to think from syncope or increasing tension of the tissues that free, deep-seated bleeding is going on, the punctured wound must be converted into an incised one, and the wounded vessel tied or twisted. The application of ice-cold dressings—or in old and enfeebled persons of warm fomentations—with opium to allay pain and induce physical and mental quietness, are the early remedies required. If inflammation occurs, relaxation of the muscles by position, absolute rest, leeches in large numbers—from fifteen to thirty—and large, hot, anodyne fomentations, must be employed. The use of a simple milk diet, attention to the bowels—but not the administration of severe purgatives—and the employment of narcotics, constitute the rest of the treatment. As soon as matter has formed it should be let out. Tonics, stimulants, and fresh air, are requisite after suppuration is thoroughly established.

LACERATED WOUNDS are occasioned by hooks, nails, or any form of tearing, such as is caused by machinery and railway accidents, or by falls from carriages or horseback, the person being dragged along whilst the abdomen is forcibly squeezed against or mutilated by some resisting substance.

Symptoms.—These wounds are usually followed by considerable suppuration of their edges, and if large flaps or strips of integument are torn or ripped up, there is often much difficulty in bringing them nicely into contact. There is usually not much hemorrhage at the time, but secondary bleeding may occur as soon as the shock of the accident has passed, or when reaction is established. Pain is often severe, but like hemorrhage is uncertain in its existence and degree. These wounds never heal by first intention. Like punctured wounds, they are prone to be followed by inflammation and suppuration; sloughing too is very apt to follow. Occasionally all the layers of the abdominal parietes are torn up, leaving the peritoneum perfectly intact. Poland, in his Fothergillian Prize Essay, has recorded the following case:—

A healthy and temperate baker, aged 38, was admitted into Guy's Hospital, having been violently dragged between the projecting ledge of a butcher's shop and his cart. All the layers of the abdominal muscles were torn up in a line from the spinous process of the right ilium to the symphysis pubis, laying bear a large surface of the peritoneum, and exposing the front surface of the bladder. The peritoneum was not wounded, but the intestines were projecting it outwards. The spermatic cord had escaped injury. There had been much hemorrhage, and he was collapsed. The urine was drawn off untinged with blood. The wound was cleansed, the ragged muscles arranged as well as possible, and the edges brought together with sutures; and the thighs and shoulders were raised. Stimulants were given and warmth applied. He soon rallied from the collapse, and his pulse improved. In the night he was bled to ten ounces, and calomel and opium were ordered. On the following day the abdomen was very tender on pressure, especially on the uninjured side, but there was no tension. Leeches were applied and castor-oil injection given, which producing no effect, a full dose of castor oil was administered, and also an injection of salts and senna before the bowels were freely opened. Some of the sutures were removed, and an offensive, thin, sanious serum mixed with bubbles of air was evacuated. The abdomen was fomented, and warm water dressing applied over the wound, the cutaneous edges of which were kept in apposition by plaster. After going on well for five days his strength began to fail and his stomach to reject everything. The wound discharged immensely, and sloughs slowly separated; and he had profuse sweats. His breathing became fast and difficult, as if the injury to the abdominal walls would not allow the descent of the diaphragm. He died from exhaustion on the tenth day. Post-mortem examination showed very little evidence of peritonitis; but the whole surface of the wound was somewhat sloughy, though inclining to take on a healthy action. Pneumonia at the back part of both lungs.

Treatment.—The general indications for treatment are such as have been described in speaking of the other forms of wound. In the lacerated wounds special care must be taken to cleanse the tissues, and to remove foreign matter with as little disturbance to the parts as possible. Pain must be relieved by opium and sedative applications to the wound. Whilst the bowels must be opened, if the patient is suffering from the effects of constipation, it is most disadvantageous to be stimulating them with aperients and injections, especially when the wound is deep and the peritoneum exposed. Here, as in all forms of abdominal injury, quietude should be obtained and the intestines kept at rest, as far as possible.

CONTUSED WOUNDS are caused by instruments which bruise as well as divide the tissues; any form of wound may be contused. Thus an incised wound may be attended by contusion, as in the case of those made by the teeth of a saw; punctured wounds are contused if inflicted with blunt weapons, as by such as increase suddenly in diameter from point to handle, whereby the tissues are forced asunder as by a wedge; lacerated wounds are always more or less contused. Perhaps the usual forms of contused wound of the abdomen are those caused by spent balls, by fragments of shell, or by some heavy body passing over it. The area of contusion generally spreads wider and deeper than the area of laceration. Some of the most severe contusions are, moreover, entirely subcutaneous; the muscles, vessels, nerves, and fasciæ may be torn without any breach of the skin.

As in lacerated wounds, so in the contused, primary hemorrhage is slight; there is, however, danger of secondary hemorrhage; sloughing and ulceration are more likely to occur than in any other kind of wound, and indeed in many cases must occur before repair can commence. Contused wounds of the abdominal parietes, if deep, are therefore necessarily dangerous; and, in punctured wounds it is the contusion of their edges, together with the difficulty there is in draining away their discharges, which gives to many of them their especial risks.

Treatment.—As contused wounds cannot heal by first intention, there is no object in suturing their edges with precision. Sutures in these, as in lacerated wounds, must be used simply with a view of preventing unnecessary gaping. After cleansing the wound and stopping bleeding, the next step is to retain the tissues in place, cover them with some antiseptic dressing, and keep up their vitality by using a thick layer of absorbent cotton-wool as a medium for warmth. As soon as sloughing has commenced, special care must be taken to prevent putrefaction. Drainage should be thorough, and to this end it will often be well to make counter-openings for the insertion of drainage-tubes. Secondary hemorrhage must be treated by tying the bleeding vessels, or by the application of styptic wool, styptic colloid, or Ruspini styptic applied on cotton-wool or lint; there is in these astringents an additional advantage, as they assist in purifying and keeping the wound sweet. To hasten the removal of sloughs, carrot or charcoal poultices, or carbolic and lead lotions combined, applied as hot fomentations, are the best remedies. Whilst paying every attention to cleanliness, it must be remembered that the wound should be kept as quiet as possible; for this purpose an easy posture, the gentle support of bandages, and, if necessary, the internal and local use of anodynes, are to be recommended. Tonics and stimulants will generally be required, and especially if the sloughing is extensive or the suppuration profuse.

GUNSHOT WOUNDS are of the nature of contused and lacerated wounds, the contusion being severe and extending to the surrounding tissues, as well as along the track of the missile. Hence it is that, in these cases, death often results from peritonitis, or from shock. Shock is occasionally very intense, even when the wound is comparatively superficial.

Symptoms.—Gunshot wounds generally present a blackish coloration at the edges of the aperture of entrance, and the surrounding parts are red or purple at first, and yellowish-brown or violet after a day or two. They differ widely according to the form and size of the projectile, its degree of velocity, and its direction. It is probably due to the smaller size and less velocity of the bullets used in civil life, that the consequences of gunshot, parietal wounds of the abdomen are not as severe in civil as in military practice. Even in warfare, non-penetrating wounds are attended with a low mortality, whilst in civil practice recovery is the rule. Setting aside the risks of peritonitis, the immediate consequences of shock, and the complications which arise out of wounds of the kidney, colon, or bladder, etc., a favorable prognosis may be given with fair certainty. Hemorrhage is not common in gunshot wounds, though severe primary bleeding may occur if the kidney or some large parietal vessel, such as the deep epigastric, has been wounded; and though secondary hemorrhage should be expected between the seventh and twelfth days, when the sloughs separate if an artery or vein has been contused. It must always be borne in mind that abscess and diffuse suppuration are likely to arise in the track of a bullet. A fistulous opening, attended with swelling and pain, and giving rise from time to time to profuse discharge, may ensue; pieces of clothing and of fractured bones may be discharged or removed. The numbness which is felt at first after a gunshot wound, is frequently succeeded in a few days by intense pain. When a ball, instead of traversing the tissues directly, becomes deflected by the edge of a rib, the xiphoid cartilage, or a layer of fascia, it may emerge at the opposite side of the trunk, and give the appearance of having passed straight through its cavity; thus a bullet, penetrating the skin at the scrobiculus cordis, has been known to traverse the cellular tissue beneath the skin, and make its way out again at a spot diametrically opposite to the wound of entrance; or, after deviating thus in its course, it may just fail to make its exit. I have had to remove from beneath the skin, close to the spinous process of the tenth dorsal vertebra, a pistol-bullet, which had entered the abdominal parietes opposite the anterior extremity of the tenth rib; the bullet had travelled around in the substance of the parietes. A ball may scoop or gutter out a portion of the integument without lodging or penetrating.

Diagnosis.—A certainty as to whether the abdominal cavity has been penetrated or not, cannot be arrived at from the apparent direction or course of the shot, neither is shock or functional derangement of the viscera sufficient evidence of penetration. Indeed, nothing short of actual ocular or digital demonstration of the peritoneum, the protrusion of viscera, or the escape of their contents, can be received as actual proof that the wound is a "penetrating" one. The peritoneum may be exposed or bruised, or separated from its parietal connections, without being penetrated; and the kidney, colon, bladder, or other extra-peritoneal organ, may be wounded without the peritoneal cavity being opened, and without extravasation into that cavity occurring. Such complications, however, greatly increase the dangers of gunshot wounds of the parietes. Guthrie relates a case in which a musket-ball made a wound about four inches in length above the crest of the left ilium, and cut away the abdominal muscles so deeply as to expose the peritoneum. Ulceration of the serous layer was feared at the time of the separation of the sloughs, but, instead, granulations sprang up from the sides and bottom of the wound, which gradually healed without trouble. Guthrie adds that he had seen the same thing occur many times; so that he had no doubt of the great power possessed by the peritoneum in resisting ulcerative action going on in its immediate neighborhood.

Treatment.—The depression and general collapse which follow gunshot wounds of the parietes, will often require the cautious but liberal use of stimulants, and warmth to the extremities and spine. The next step is to remove the missile, or any extraneous substance which may have been carried in before it. The clothes should always be examined; it sometimes happens that a fold of a shirt or flannel is carried into the wound in front of the ball, without being torn, and that the ball is removed in the process of taking off the clothes. A nearly spent ball may enter the parietes a short distance, and then fall out by its own weight. Sometimes, though nothing is felt for a time, the ball by a lucky change of position presents itself at the wound, and can then be removed; or, failing this, it may gradually work itself out if its escape is favored by posture. If it appear that the ball has lodged in the tissues, search should be made by digital examination, not only of the trunk but of the limbs also, especially along the direction in which it is probable, from the account given, that the missile has traversed. Thus, a ball may take an upward or downward course in the sheath of the rectus muscle; or may skirt along Poupart's ligament and the iliac crest, outside the peritoneum, and thus reach the liver; or, following the course of a rib, may be found at the opposite end of the bone; or may pass downwards to the buttock or thigh, or upwards to the shoulder or axilla, or may sink into the pelvis and be subsequently cut out in the perineum. Digital examination and probing should be conducted with extreme care, owing to the risk of forcing an opening, in this way, into the peritoneal cavity. If there be no indication of its whereabouts, the ball must be left to become encysted, though, instead of becoming encysted, it may shift, and subsequently be detected. Hennen relates a case in which a piece of shell, nine and a half ounces in weight, and of an irregular and quadrilateral form, was detected three weeks after the injury, and felt by the patient to change its place to a certain degree according to the position of his body; yet previously there had been no indication of its presence. It was removed from the right lumbar region, through an incision four inches long and half an inch deep, and the patient recovered.

Should a ball be found beneath the skin, it should be removed with as little disturbance as possible, through an incision made down upon it. Immediately after the removal of the ball it will be well to send a gentle current of some antiseptic fluid (Condy's fluid or carbolic-acid lotion) along the track. In this way I have washed out small pieces of clothing, which would have given rise to irritation and discharge, if not to abscess, had they been left. After inflammatory swelling has once begun, it is not likely that such foreign substances will escape until after the establishment of free suppuration. During the period of inflammation, leeches and warm fomentations, with salines, refrigerants, and opium, are requisite. Sloughs must be removed; and collections of unabsorbed blood or of pus should be freely laid open, to prevent the extension of inflammation to the peritoneum. Absolute quietude of the trunk and of the abdominal viscera are important points in the treatment. If the kidney be wounded, provision must be made for the free escape of urine and pus; if very badly wounded, or if hemorrhage from it be persistent and alarming, or if it be prolapsed, lumbar nephrectomy should be performed.

II. Penetrating Wounds of the Abdomen.

Penetrating wounds of the abdomen may be divided into: (1) simple wounds; (2) wounds with protrusion of, but without injury to, the abdominal contents; (3) wounds with protrusion and injury; and (4) wounds without protrusion of, but with injury to, the viscera. It has been already stated that these wounds, like the non-penetrating, may be either incised, punctured, lacerated, contused, or gunshot; but after the foregoing description of non-penetrating wounds, it is unnecessary to describe the penetrating under these headings. The relations of the wound to the viscera and to the peritoneum, give the leading characters to penetrating wounds.

In judging of wounds of the abdomen, we are likely to be deceived by the appearance of the patient, as well as of the wound. He may be conscious, comfortable, and calm, though the subject of a most severe and critical wound; or he may be restless, trembling, and alarmed, though there is but slight, if any, actual danger. The wound itself, though on the surface simple, may be serious within—the peritoneum being punctured, lacerated, contused, or widely detached; or some deep vessel may be injured, and alarming hemorrhage may be going on. Again, the wound may be large and lacerated at the surface, whilst little or no damage has been done to the deeper structures. Wounds of the abdomen not immediately fatal, but which subsequently terminate fatally, do so in much the same general way. Just as wounds of the head lead to death by delirium or coma, and wounds of the chest by dyspnœa, hæmoptysis, and syncope, so wounds of the abdomen kill by inflammation and gangrene, and the signs of these processes are tympanites, vomiting, hiccough, thirst, a sense of bursting, clammy sweats, and distressing restlessness.

Simple penetrating wounds are unattended at first by any other symptoms than those common to non-penetrating wounds of a corresponding character. If all goes well, and the patient makes a good recovery, as in many incised penetrating wounds is the case, there is neither collapse to start with, nor peritonitis to retard the cure; and even when the injury has been followed by a good deal of shock, the subsequent course of the case may be quite simple and satisfactory, the symptoms negative, and the convalescence quick. In many cases, especially if the wound is narrow, or oblique, it is difficult or even impossible to say whether it penetrates or not, unless the surgeon indulges in an unwarrantable curiosity and probes the wound. The case may, therefore, run its course to a successful termination, and the surgeon be left in doubt whether he has had a non-penetrating or a penetrating wound to treat. In drawing any inference as to whether the peritoneum has been penetrated or not, the varying thickness of the parietes as well as the force and direction of the blow, if this can be ascertained, and the size of the wound as compared with the shape and size of the instrument, must be taken into account. A force which would penetrate a thin abdominal wall may not a fat one; and a force which would drive an instrument quite through at the epigastrium may not go half-way through at the flank. Again, care must be taken not to mistake a lobule of fat, projecting from the wound, for a piece of omentum. One great source of danger in penetrating wounds was formerly supposed to be the irritation set up by the entrance of air; but John Bell ridiculed this doctrine, and concluded: (1) that air could not really be thus admitted into the cavity of the abdomen, and (2) that even if freely admitted it was incapable of producing the dreadful effects which had been ascribed to it. With the substitution of "germs in the air," for "atmospheric air," the old scare is still existing, and the antiseptic spray is the antidote thereof. But as, from the most recent statistics of abdominal operations, performed with and without the spray, there is scarcely a fraction of difference in the results, and one is at a loss to know on which side the advantage really is, there is good reason to think that Bell's observations[1] respecting atmospheric air and its influence on these operations, may be applied with equal force to the modern theory.

But though the admission of air has not the evil influence imputed to it, the inflammation of the peritoneum which it is supposed to excite, does too often occur from other causes, and that too whether there be injury to the viscera or not. It has been written that a discourse on wounds of the abdomen must be a discourse on inflammation of that cavity, and on the various ways in which it is produced. Though this happily is a great exaggeration, it yet must be acknowledged that the slightest scratch or wound of the peritoneum, may, under some circumstances and in certain constitutional states, excite general peritonitis. As a rule, however, the inflammation excited by wounds results from some injury to the viscera, and from the escape, into the cavity of the peritoneum, of some fluid or foreign substance which even the active, absorbent power of that membrane cannot remove. A limited amount of inflammation, such as fortunately follows the majority of simple wounds of the peritoneum, terminates in union by adhesion; and this purely local process rapidly heals the injury, without giving rise to any symptoms or causing any disturbance within the abdomen. But it sometimes happens that the inflammation, instead of being restricted to the lips of the wound, extends very widely over the surface of the peritoneum. It is the tendency of inflammation when it attacks a shut sac, no matter how slight the cause, nor how small the area first affected, to run rapidly over the whole of its surface; and it is this tendency which gives the danger to peritonitis: (1) because of the large number of organs necessary to life, which are covered by the peritoneum and are thus affected by the inflammation of that membrane, and (2) because of the extent of this serous membrane and of the irritation excited by the products of its inflammation.

In a wound of the abdomen, as in one of the pleura, pericardium, a large joint, or a large vein, the inflammation spreads widely over the lining membrane, if its surfaces are not brought into contact, so that they can adhere; on the other hand, if the wounded surfaces touch each other, the inflammation is limited by its own adhesive tendency. Thus it is that inflammation of the peritoneum, though the chief cause of danger in simple penetrating wounds of the abdomen, is also the only means of cure, by causing adhesion of surfaces and closure of the wound. Constitutional disposition and visceral degeneration influence the character of local inflammation, wherever situated; and there is, probably, an essential difference between the circumscribed, salutary inflammation which closes a wound, and the pernicious and too often fatal inflammation which spreads indefinitely by continuity.

The symptoms, diagnosis, pathology, and treatment of traumatic peritonitis have been already fully described, so that there is no occasion to refer further to the subject here. How severe a wound, even of the lacerated kind, and involving a large tract of peritoneum, may be entirely and quickly recovered from, is shown by the following case recorded by Sir James Macgrigor for Dr. Kennedy.[1]

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[1] Discourses on the Nature and Cure of Wounds, 3d ed., p. 347.

A man employed at the Chank fishery near Manaar was bitten by a shark. The upper jaw of the animal had been fixed in the left side of his belly, forming a wound of nearly a semicircular shape, of which about one inch on the left side of the umbilicus was the upper, the lower part of the upper third of the thigh the lower extremity, and an inch behind the trochanter the centre. The abdominal and lumbar muscles were divided and turned up, exposing the colon in its passage across the belly, and several convolutions of the small intestines, and laying bare three of the lowest ribs; the gluteal muscles were lacerated and torn up; the tendons about the trochanter were divided, laying bare that bone, and the vastus externus and part of the rectus muscle of the thigh were cut across. The lower jaw of the fish had been fixed in the muscles of the right side of the abdomen, forming a segment of a circle between the umbilicus and one inch above the pubes; the teeth of this jaw had penetrated without otherwise lacerating the tissues. The measurements of the wound were 19 inches in length by between 4 and 5 in breadth. The accident had occurred three hours, and the patient had been carried first in a boat and then in a palanquin over five miles, before he was seen by Dr. Kennedy, who freed the abdomen from salt water and blood, and cleansed the wound from clotted blood and hair, closing it with straps of adhesive plaster around the body, a light dressing, and a many-tailed bandage. As the bowels had not acted for two days previously, a clyster was ordered the same evening, and was followed by two actions, one immediately and the other during the night; he was bled the next day, opium was given as required, castor oil was administered from time to time, and a light, fluid diet was ordered. The opening into the abdomen had perfectly closed by the sixteenth day, the whole of the wounds granulated, and the man did well.

Treatment.—Such a case as the above should encourage the surgeon to hope even against hope in the treatment of penetrating wounds. Every attention should be given both to the local and general treatment of the patient, as if there were certainty of recovery if only all proper care were taken. Indeed, it should be a rule in surgery that nothing, whilst life lasts, should be treated as hopeless, whatever we may think about the result. By insisting on this principle of action, I have more than once witnessed recovery under the most desperate circumstances, and when the disposition of the attendants was to give up the case as lost. The wound having been cleansed, bleeding checked, sutures inserted, and some light, elastic, and antiseptic dressing applied, the patient should be placed in a comfortable position so as to relax the abdominal muscles. The sutures in all cases of penetrating wound of the abdomen should be passed from the peritoneum outwards, the whole thickness of the parietes, including the peritoneum itself, being traversed. The general treatment consists in bleeding, by leeches on the abdomen or by venesection at the elbow, if the patient be plethoric or the inflammation run high; in the administration of low diet and the strict avoidance of solid food; in the enforcement of absolute quietude, with the use of opium to relieve pain and check peristaltic action of the intestines; and in the employment of enemata to clear the rectum if necessary.

PENETRATING WOUNDS WITH PROTRUSION OF UNINJURED VISCERA.—The peculiar arrangement in planes of the abdominal muscles, the direction of the fibres of each of which differs from that of the others, allows of the parietes being wounded to a considerable degree without protrusion following; yet if the wound be in a part where the aponeurotic structures prevail, a considerable prolapse may take place through a small incision. Perhaps, however, it may be stated roughly that the degree of protrusion will be in proportion to the size of the wound, and that the viscus protruded will depend on the anatomical contents of the region wounded. The small intestines and the omentum have the greatest tendency to protrude, but any portion of the intestinal canal, from the stomach to the sigmoid flexure, may be forced through the wound. The duodenum, unless dragged with the stomach, is rarely, if ever, protruded; and the cæcum and sigmoid flexure are less likely to escape than the transverse colon. The bladder has occasionally protruded through a wound in the hypogastrium. It is recorded that the solid viscera have been partially or entirely protruded, but such cases are more rare. Incised and lacerated wounds are more frequently followed by these protrusions than punctured or gunshot wounds.

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[1] Med.-Chir. Trans., vol. ix. p. 240.

Treatment.—When the wound has been recently inflicted, and the protruded organ is uninjured, it should be returned to the abdominal cavity without delay. This should be done in a definite and methodical manner, returning those parts first which have protruded last, and beginning at the upper end and following in the regular course of the intestine; the stomach should go before the small, and the small before the large bowel, and omentum after intestine. If the protruded parts are dirty and covered with sand or hair, etc., they should be washed clean by a gentle stream of warm milk and water, or of warm water squeezed from a clean sponge, or allowed to flow from an irrigator, until every particle of foreign substance is removed; and then they should be returned. In returning them, care must be taken not to force them between the different planes of the abdominal wall, or into the sheath of the rectus, or between the peritoneum and the pelvic cellular tissue instead of into the peritoneal cavity. It should be borne in mind that the peritoneum in old people, and in certain regions, is very easily detached, and that it has happened that large portions of protruded viscera have been forced into false sacs so formed, instead of into the abdomen. To avoid this, it is best to follow the returning mass with the finger, and thus ascertain that a clean, smooth sweep can be made upon the inner surface of the parietal peritoneum.

There may be obstacles to the return of the protruded structures:—

In the first place, the *narrowness of the aperture* may resist the efforts of the surgeon. To obviate this, the abdominal parietes should be relaxed by position as much as possible, and retractors should be inserted so as to separate the margins of the opening and prevent them from being pushed back by the taxis. If these measures are insufficient, the opening should be enlarged with a probe-pointed herniotome or bistoury, dividing first the aponeurotic or muscular tissues, and sparing the peritoneum if possible. In making this incision, care must be used not to wound the intestine, nor to divide any large artery, nor to cut across the direction of the muscular fibres, which would leave the parietes permanently weakened. If a probe-pointed knife cannot be passed between the edge of the wound and the protruding organ, the wound should be enlarged by carefully cutting through the tissues from the surface, with a sharp-pointed scalpel.

If it be *omentum* protruding, reduction may be difficult or impossible on account of its congested and œdematous state, or because it is adherent to the edges of the wound by lymph poured out into its meshes; or reduction may be undesirable on account of its inflamed or even gangrenous condition. If it be quite healthy, and the patient be seen within a short time of the accident, and if the reduction fails simply on account of the size of the protrusion as compared with the size of the wound, this should be enlarged in one of the ways just specified. But if it be deeply congested, partially strangulated, inflamed, or adherent to the wound, it is unwise to return it into the peritoneal cavity. The proper plan is to apply one or more ligatures to it, on a level with the edges of the wound, to cut the ligatures short, and to cut away the part of the omentum beyond the ligatures, leaving the stump at the wound if it be already adherent to its edges, but returning it just within the abdomen if it be not adherent. Before thus treating omentum, care should always be taken that no knuckle of bowel is hidden within or behind it; and also that the prolapsed portion is not such that, after cutting it away, a loose, unattached end shall be left in the abdominal cavity. I have on two or three occasions seen the protruded omentum forming a complete sac, with a large knuckle of intestine within it. I have also, at a post-mortem examination, found a piece of omentum, about four inches by two, lying loose and gangrenous in the abdominal cavity; the omentum had been doubled upon itself, and an elongated loop of it had protruded; this the surgeon had tied with a double ligature and cut away, leaving one ligature upon the lower end of the mass, and the other upon the upper end of what proved to be a portion thus completely separated from the rest. Death was caused by peritonitis, set up by this detached piece of omentum left in the peritoneal cavity. Such a fatal error would be avoided by carefully unravelling the omentum before tying it, and, if such a condition as the above were found, and the omentum were not in a fit state to return, it would be best either to draw out the free end before ligaturing it, or to leave the omentum to form adhesions at the wound, after which the projecting part could be removed if it did not slough away; in either case the stump would cicatrize in the wound. If the omentum be gangrenous, there can be no question as to the propriety of removing it after the application of a ligature to its base, bearing in mind the precaution just stated. The ligatures should be of catgut or good silk, and should be cut off half an inch beyond the knot.

When the omentum is allowed to slough, the patient suffers pain and uneasiness about the wound, and over more or less of the abdomen, and often has a feeling as if a cord were tied tightly around the belly. He has also a sensation of nausea, or actually vomits, and in a short time the symptoms of general peritonitis ensue. The protruded omentum first adheres to the edges of the wound and the subjacent parietal peritoneum, a quantity of serous fluid is poured out, and it swells from venous congestion. It loses sensitiveness and becomes discolored, being mottled, bright-red, and dusky-brown, then deep-purple, and, lastly, dingy-black; it is then thrown off like other sloughing tissues. The remainder is healthy-looking and granulating, and gradually contracts as it cicatrizes, until it leaves a scar on the level of the skin, or slightly cupped and depressed below it. Many surgeons of great repute have advocated the plan of leaving the omentum to slough; it was strongly advised by Key, recommended by Guthrie, and preferred by Poland; but it cannot be gainsaid that excision obviates the tediousness of the sloughing process, while experience has shown that the ligature, when properly applied, is not attended with the dangerous consequences attributed to it. Moreover, it is absolutely demanded when the omentum is not fit to be returned, and yet the constricting force at the wound not sufficient to effect separation by sloughing. In operating for hernia I have often ligatured and removed large portions of the omentum, and have had no reason to question the safety and success of this mode of treatment.

Protruded *intestine* may be irreducible from one of several causes, or may be partially strangulated, or completely gangrenous. It may so increase in size from accumulated gas, that reduction is impossible until the gas is pressed out, or allowed to escape through an aspirating tube, or until the parietal wound is enlarged. This latter step must be taken with great care, however, because of the difficulty in preventing fresh portions of the gut from protruding through the enlarged aperture, when flatulent or fluid distension is general. Puncturing the distended and protruding gut has been advocated by many surgeons, including Paré, Garengeot, Sharp, Van Swieten, and several modern authorities; and it has been in some cases very successful. But it has its dangers, and especially if the distension has been great and prolonged, and if the intestinal coats are softened by inflammatory changes. Under these circumstances the puncture-holes are apt not to close, but to allow of leakage of the intestinal contents. I have seen this catastrophe necessitate the establishment of an artificial anus, and have more than once witnessed the use of circular ligatures to close the openings. It is a practice which should never be pursued in an inflamed, over-stretched, softened, or otherwise diseased bowel; and even in healthy tissues it should be avoided, if by gentle manipulation and moulding of the protruded gut, or by moderate enlargement of the opening, reduction can be otherwise effected. But the bowel may also be irreducible owing to the protrusion with it of omentum, which has become congested and œdematous; in this case the omentum should be treated by ligature and removed, and then the bowel should be returned. Again, adhesions may have formed between the bowel and surrounding parts, at or outside the opening, in which case they must be gently broken down or divided, when, after stopping bleeding, if there be any, the intestine can be replaced. If the bowel be strangulated, it may be in one of three conditions: (1) simply congested; (2) actively inflamed; or (3) actually gangrenous. Respecting the two former conditions, there can be no doubt that the practice to adopt is the same as in hernia—viz., the opening should be enlarged, and the bowel returned as soon and as gently as possible. There is no place like home for a sick bowel, as for a sick man. But if the gut be in a state of gangrene, commencing or complete, it is death to the patient to return it to the peritoneal cavity; it is to cast the corrupt and festering carcase into the chamber of the living—to poison life by the putrefaction of death. If, then, the bowel has lost its polish, and is of a dusky or brownish-black color; if its coats tear readily and are tumid and swollen; still more, if there are greenish or ashen-gray spots in them, the surgeon—knowing that such conditions are past repair, that sloughs must separate, and that an artificial or false anus must form—should leave the bowel in the wound, and wait for the formation of a false anus, or else perform enterectomy. If the former plan be selected, and all goes well, adhesive inflammation will attach the gut firmly to the edges of the parietal wound, the peritoneal cavity will be safely cut off before the sloughs separate, and there will be then no danger of fecal extravasation into it. On the other hand, pain, vomiting, abdominal distension, weak pulse, and general depression, may point to an unfavorable termination from collapse or inflammation; or the false anus may be so high up in the bowel that, the chyme escaping through it, death will occur sooner or later from inanition. It may here be mentioned that, as the portion of bowel below the strangulation is empty and contracted, the nearer the seat of strangulation is to the stomach, the less distended will be the abdomen, and the quicker and more severe will be the symptoms. Enterectomy in these cases, therefore, should be performed.

Remarkable cases of recovery after wounds of the abdomen with protrusion, are related by Mr. Hayne,[1] by Dr. Shearman,[2] and by Bransby Cooper.[3] B. Cooper says:—

> I have heard my colleague, Mr. Morgan, relate a case, in which a boy at Tottenham received a wound in the abdomen through which a large quantity of intestines protruded; he placed the viscera in his pinbefore and walked a considerable distance to a surgeon, who freed the bowels from a quantity of dust which adhered to them, returned them into the cavity of the abdomen, and sewed up the wound by the uninterrupted suture; by this judicious treatment the patient was restored to health.

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[1] Edin. Med. and Surg. Jour., vol. v. p. 129.

[2] Provincial Med. and Surg. Jour., Aug. 1845.

[3] Surgical Essays, p. 264

Protrusion of the *solid organs* is a rare occurrence, but several cases are on record. In some instances, portions of the liver have been cut off, either without or after applying a ligature around the protruding part. Dr. Macpherson's case,[1] and one quoted from Dieffenbach's journal by Professor Dunglison, may be referred to. Recovery has followed the removal of a protruding spleen, of a kidney, and of a large part of the pancreas.[2]

The *treatment* to adopt in such cases ought to depend upon whether the protruded organ is wounded or not, and how long it has been protruded. If it be not wounded, and the case be seen directly, the proper practice is to return it, and to this end the wound in the parietes should be enlarged, if necessary; if wounded, or if the organ be damaged from long exposure, it is unsafe to return it; a ligature should be applied, and the protruded part cut away, if it be the liver which is involved. In the case of the kidney, and perhaps also of the spleen, the whole organ must be excised. Dr. Blundell[3] states that Mr. Cline used to relate the case of a soldier whose side was laid open by a sabre-wound through which the spleen protruded, and lay out in the dirt for some hours. It was removed by the surgeon, and the man recovered without any subsequent inconvenience. A case is recorded[4] in which the spleen, after being protruded for twenty-four hours through a wound in the left hypochondrium, was found irreducible, cold and black; a strong, waxed thread was tied around it, above the unsound part, and 3½ ounces of the spleen were cut away; another ligature was then required, to a large spurting artery, and after the parts were well bathed with warm water, the rest of the spleen was returned, with the threads hanging out of the wound. On the tenth day the threads were removed, and ultimately the man got quite well. In this case the patient had difficulty in passing water for eight days; and in another case referred to by Dr. Blundell, in which the whole spleen separated completely from the body on the twentieth day after the wound, and the eighteenth day after the application of the ligature, there was bloody urine till the tenth day; but the man was well by the forty-fifth day.

Protrusion of the uninjured *bladder* occasionally, though very rarely, occurs. Just as it has been observed as a rare occupant of a hernial sac, so in exceptional cases the bladder has projected through a wound in the lower part of the abdominal parietes. Samuel Cooper saw three such cases at Brussels, after the battle of Waterloo.

Before such a thing can occur, the capacity of the bladder must have been greatly increased by over-distension of its walls. Protrusion of the bladder through a wound in the abdominal walls may occur without penetration of the peritoneal cavity; and even when this is opened, the prolapsed part of the bladder is only partially covered by peritoneum, but the greater the prolapse the more extensively is that membrane involved. When protruded, the bladder forms a soft, compressible swelling, which, as a rule, is easily reduced by pressure, the reduction being accompanied by an urgent desire to pass water. The *treatment* consists in reducing the protrusion, and in introducing a soft catheter, which should for a time be retained.

The treatment of all wounds of the parietes, after the reduction of protruded viscera, is the same as that of simple, penetrating wounds. In passing the sutures, care must be taken not to injure any of the viscera, and not to allow blood to trickle from the punctures back into the peritoneal cavity; both these objects are attained by introducing a flat sponge, if the wound be a large one, and spreading it out upon the viscera until all the stitches are introduced; it should then be withdrawn before tightening the last suture. If the omentum or bowel be left projecting at the wound, the edges should be brought together only in part by sutures. It is not necessary to stitch the bowel or omentum to the wound, and no ligature should be left projecting at the wound if the stump of tied omentum is returned into the cavity.

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[1] Med. Gaz., January, 1846.

[2] See section on Penetrating Wounds of Pancreas.

[3] Blundell's papers in Dr. Ashwell's Practical Treatise on Parturition. London, 1828.

[4] Philosophical Transactions, vol. xl. p. 425.

Penetrating Wounds with Protrusion of Injured Organs.—In these we have the additional complication of a wounded viscus, which, as regards protrusion, may be in any one of the conditions described in the foregoing section. It will only be necessary to refer here to the various kinds of wounds of the viscera, and their treatment and results, without reiterating the remarks relative to protrusion. The appearances of *wounded intestine* have been described by Haller,[1] Benjamin and John Bell, Travers, Gross, and many others. Travers[2] writes, "before adverting to the consequences of wounds inflicted upon the exposed intestine, it will be necessary to describe certain appearances which the wounds exhibit, *depending upon the action of the bowel.* If a gut be punctured, the elasticity of the peritoneum and the contraction of the muscular fibres open the wound, and the villous or mucous coat forms a sort of hernial protrusion and obliterates the aperture. If an incised wound be made, the edges are drawn asunder and reverted, so that the mucous coat is elevated in the form of a fleshy lip. If the section be transverse the lip is broad and bulbous, and acquires tumefaction and redness from the contraction of the circular fibres behind it, which produces, relatively to the everted portion, the appearance of a cervix. If the incision is according to the length of the cylinder the lip is narrow, and the contraction of the adjacent longitudinal, resisting that of the circular fibres, gives the orifice an oval form. This eversion and contraction is produced by that series of motions which constitute the peristaltic action of the intestines." From his experiments, he concludes that, if the gut is cut across, the orifice to some extent opens and closes alternately by the muscular motions of the bowel, so that the contents are alternately ejected and arrested; if the wound is longitudinal, that is, in the axis of the bowel, the aperture remains patent, there is but little alternate contraction and dilatation, and the contents issue freely. In the punctured wound, the mucous coat is everted and constantly fills the opening, and is elevated somewhat above the peritoneal surface; "it was the only form of wound not followed by effusion. In the lacerated wound, the eversion was so slight as to be scarcely perceptible." There is less tendency for transverse than there is for longitudinal wounds of the bowel to be spontaneously repaired, owing to the greater disposition of the edges of the transverse wound to recede from one another, and to have their mucous coats everted; thus, union by adhesive inflammation is frustrated.

Treatment.—If the wound be a small one, of the punctured variety, there is but little danger that the contents of the bowel will escape, and many distinguished surgeons have recommended that no ligature should be applied; but Le Dran, Benjamin Bell, Travers, Astley Cooper, Key, Poland, and many modern surgeons, have advised the application of a ligature before returning the bowel, so as to avoid the risk of extravasation. If the wound be small, the ligature may be applied around it in the same way that a string is tied around the neck of a sac, and the ends of the ligature should be cut short. If the wound be larger, it is better to close it with a continuous suture, using a small, round, sewing needle, armed with a fine silk thread, the ends of which should be securely fastened and cut off short. The gut is then to be returned, and the external wound to be treated as if the injury had been a "simple penetrating wound." If the wound be incised, and especially if not quite a small one, it must be stitched up with one of the various kinds of suture to be presently described, preferably the glover's,[1] the spiral, Lembert's,[2] or Gely's,[3] before the bowel is returned. If the bowel be divided completely across, so that the incision involves, it may be, even the mesentery, the ends should either be stitched together in part of their circumference, and to the edges of the parietal wound in the remaining part, after the bulk of the protruded bowel has been returned; or the edges of the divided gut should be accurately united all around with their peritoneal surfaces in contact, and then returned to the abdomen, and the wound in the parietes closed in the usual way. By the former method a false anus will result; there are a variety of plans for executing the second. The former should be adopted if, owing to the age or feeble condition of the patient, or the contused state of the edges of the wound, there be reason to fear that adhesive inflammation will not take place; but if the wound be an incised one, if the patient be in fairly good health, and further, if the wound involve the upper part of the intestine, so that there would be fear of death from inanition if a false anus were formed, the complete suture should be employed, the bowel returned, and the external wound closed. If the protruded wounded bowel be also gangrenous, or if the contused or lacerated character of the wound make it probable that a slough will follow, either a false anus should be allowed to form, or, what would be still better when the circumstances of the case permitted it, enterectomy and the union of the divided ends by Lembert's or Jobert's suture[4] should be practised.

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[1] Element. Physiol., lib. xxiv. sect. 2, and Opera Minora, tom. i. sect. 15.

[2] An Inquiry into the Process of Nature in Repairing Injuries of the Intestines, pp. 85, 86.

Effusion into the abdominal cavity rarely follows a wound of the protruded *stomach*, as the contents easily escape outwards; the act of vomiting expels them through the wound as well as through the œsophagus. If the wound be small, the prolapsed portion of the stomach may be left in the external wound, with the prospect that the gastric wound will close and be completely retracted within the abdomen, and that subsequently the external wound also will close. If the wound in the stomach be large, it should be closed by suture, but in spite of sutures the healing may be hindered by a fistulous opening. If the edges of the wound in the stomach are bruised or lacerated, it will be advisable to retain them by a suture to the edge of the parietal wound; a fistulous opening will in such a case result, at any rate for a time, but there is generally a tendency for the stomach's walls to be dragged back into the belly, when complete and permanent closure takes place. It does not follow, because a cure of a wounded gut or stomach has been obtained with the attendant disadvantage of an abnormal opening, that a permanent fistula will remain. There are many cases on record in which, after several months, the opening has quite closed. Again, it does not follow, if the wounded bowel or stomach be left in the external wound there to undergo repair without the aid of sutures, that an abnormal anus will ensue even temporarily, as union by adhesive inflammation occurs at once in some such cases. In no instance in which a wounded viscus has been treated by sutures, and returned into the abdominal cavity, should an attempt be made by means of a suture to retain it near the wound in the abdominal wall; but the external wound should be closed, and the case treated precisely as one of "simple penetrating wound."

Terminations.—Thus it will be seen that protruded, wounded intestine or stomach may heal after being returned to the abdominal cavity, and that the cure may be quite complete, in some cases after, in others without, sutures having been used; that the cure may be effected without an abnormal opening, though the wounded viscus become fixed to the parietal peritoneum beneath the external wound; that the cure may be attended with a false anus or fecal fistula, which may or may not close after a longer or shorter time; that recovery may take place after the dangerous and somewhat complicated proceeding of enterectomy; or, finally, that death from peritonitis or collapse may occur in consequence of primary or secondary effusion of the contents into the peritoneal cavity, or even without such effusion taking place.

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[1] See Vol. II., page 29, Fig. 211, *supra*.

[2] See Vol. II., page 195, Fig. 284, *supra*.

[3] See Vol. II., page 195, Figs. 285–287, *supra*.

[4] See Vol. II., page 196, Figs. 289, 290, *supra*.

The mode of union of wounds of the intestine, whether by means of the suture or through the agency of unassisted nature, is precisely the same. Travers says "it commences with the agglutination of the contiguous mucous surfaces, probably by the exudation of a fluid similar to that which glues together the sides of a recent flesh-wound when supported in contact. The adhesive inflammation supervenes and binds down the reverted edges of the peritoneal coat, from the whole circumference of which a layer of coagulable lymph is effused, so as to envelop the wounded bowel. The action of the longitudinal fibres being opposed to the artificial connection, the sections mutually recede as the sutures loosen by the process of ulcerative absorption. During this time the lymph deposited becomes organized, by which further retraction is prevented and the original cylinder with the threads attached to it are encompassed by the new tunic. The gut ulcerates at the points of the sutures, and these fall into its canal. The fissures left by the sutures are gradually healed up; but the opposed villous surfaces, so far as my observation goes, neither adhere nor become consolidated by the granulation, so that the insterstice marking the division internally, is probably never obliterated." An inspection of the external surface of the intestine would not, however, discover even at a recent period after the injury the spot at which the division had taken place. Travers (and from his earlier experiments, Reybard also) was of opinion that the edges of the divided mucous membrane never united with each other, but that the interspace between them was occupied by organized lymph, and that this formed a complete cicatrix adhering to both the serous and muscular coats. Travers remarks that "the adhesion which takes place between the mucous surfaces in a few hours after their connection by suture, is in no instance permanent, being destroyed by the retraction of the divided parts when the sutures loosen. But if this retraction could be prevented and the mucous surfaces were retained in contact, it is probable that no organized and no permanent union could take place betwixt them, for the internal coat of the bowel is indisposed to the adhesive inflammation."[1] It is on this account that the sutures, when cut short and not left projecting from the external wound, always pass into the canal; when left long and projecting from the external wound, they ulcerate towards the serous surface and escape through the peritoneal cavity. This is one of the great dangers of the practice of leaving the sutures long and communicating with the outer wound. Other writers, such as Pétrequin, Jobert, and Gross—and Reybard also, from his later experiments—conclude that the mucous coat can cicatrize completely like the other tunics. Gross remarks that the adhesion of the mucous membrane, though achieved more slowly than that of the other tunics, is ultimately complete and may occur in one of two ways: (1) either the edges come into contact by the gradual absorption of the effused lymph, and then coalesce after a period varying from a few weeks to as many months; or (2) sometimes, but not often, the breach in the mucous membrane is healed by granulations. Pétrequin points out that though the mucous tunic is regenerated, yet the villous surface is thinner than natural, and a slight depression exists at the seat of suppuration. Jobert, in support of his view that the mucous membrane is reproduced at the line of division, quotes a case recorded in the Lancet for 1848. Dr. Thompson, Regius Professor of Military Surgery in the University of Edinburgh, showed that it was sufficient for the purpose of union to include only the peritoneum in the suture. Travers states further that the uniform contiguity of the peritoneal surfaces, and their ready disposition to assume the adhesive inflammation, are the means provided by nature for the reparation of intestinal wounds and injuries;[1] and that by this method of nature, punctured and small incised wounds, transverse or longitudinal, and apertures caused by excision of gut-substance, readily admit of spontaneous cure. Travers even thinks it just possible that, under certain conditions, the intestine, after having been half divided, may be imperfectly restored by this same method of nature; but that complete division (or what he calls direct division) of the tube is irreparable except when effected by the action of a stricture (which is what he calls indirect division), natural or artificial, in which case the injury admits of perfect and speedy recovery. In his well-known experiment of applying a ligature around the duodenum of a dog, the ligature ulcerated through into the bowel, the canal of which was perfectly re-established; a transverse fissure marked the seat of the ligature, and the appearances corresponded with those of union after suture. The dog had quite recovered by the fifteenth day after the operation, when he was killed and inspected.[2] Dr. Gross repeated this experiment, and found that the period requisite for the escape of the ligature was very variable.

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[1] Inquiry into the Process of Nature in repairing Injuries of the Intestines, etc., p. 131.

A ligature which includes a portion of the intestinal wall, such as that sometimes adopted for punctured wounds, is followed by adhesive inflammation, and thus the ulcerated wound made by the ligature is closed in the same way as a simple incised wound of the bowel. Sutures, in whatever way introduced, except when the ends are retained at the external wound, separate inwards and pass off through the anus. In the case of sutures of any absorbable material, such as catgut, it is probable that the ulcerative process does not extend into the canal, and that the knots of the sutures are for a time, that is, until their complete absorption, encysted. The species of suture is of secondary importance, provided that the cut ends of the bowel are brought into accurate contact throughout their entire circumference; if this be done, the mode of repair proceeds on the lines above stated; and, with the exception that the cylinder of the bowel is maintained through the instrumentality of the sutures, instead of by the supporting contact of surrounding structures, the same uniform principle is followed after sutures as in spontaneous union.

The solid organs—the liver, spleen, kidney, and even the pancreas—are not excepted from the liability of being protruded and injured. (See the special sections on injuries of those organs.)

PENETRATING WOUNDS WITH INJURY TO, BUT WITHOUT PROTRUSION OF, THE VISCERA.—These are even more serious than those of the last group. They differ from them, too, in that it is often impossible to recognize them. There is no doubt about the nature of an injury when the wounded viscus is protruding, but there are no certain means of verifying a wound, at least at the outset, when the viscus is not protruding, save by the escape of feces, bile, urine, or the ingesta, through the outer wound. The abdominal viscera are always naturally in accurate contact with the parietes, and that penetrating wounds do not always involve the subjacent viscera, is due to the readiness with which these are displaced. But the question at once arises, if the stomach or intestines are wounded, and their contents are not evacuated externally, whether they will escape into the abdomen. Now in these wounds, as in those followed by protrusion, the viscera may be either punctured, incised, contused, or lacerated; and much depends upon the character of the wound as to whether effusion of the contents will occur or not. Other circumstances also influence this event. Thus, if the intestinal tube be full, or nearly so; if the wound be large; if it be in the longitudinal axis of the bowel, so that the circular fibres cause it to gape instead of to contract, as is the case in a tranverse wound; or if the opening be lacerated, or ulcerated, so that the mucous coat does not protrude through the wound in the other coats, the contents will escape rapidly. Whereas, if the tube be empty, or nearly so, and the wound be a punctured or small incised one, there will be little if any tendency to extravasation. The equal and uniform pressure within the abdomen opposes an efficient, though passive, resistance to the effusion of the visceral contents, and this too even in cases in which the wounds are not of very small size. Effusion may be anticipated in proportion to the degree in which this passive resistance is overcome by the circumstances of the injury; thus, if the gut be full and the wound extensive, there is little or none of this passive resistance to the natural action of the bowel to expel its contents. There seems abundant proof from experiments and reported cases, that effusion does not usually occur unless these two conditions (repletion and extensive wound) are combined; but an exception must be made as to cases in which air or blood has been extravasated into the abdomen at the time of the injury. That the integrity of the abdominal parietes does not prevent the escape of the intestinal contents, is proved by the greater frequency of effusion in cases in which, without any injury to the abdominal walls, the bowels or stomach are ruptured, or perforated by ulcers, or by worms or other foreign bodies. The explanation of this is to be found in the nature of the injury to the bowel. A rupture by concussion or compression, is seldom of small size, and, as a rule, takes place when the tube is distended; and a perforation by ulcer, being attended by a loss of substance more extensive on the mucous than on the peritoneal surface, is not a mere solution of continuity like a puncture or incision. On the other hand, effusion is not facilitated by the division of the parietes, unless the opening be large enough to admit of prolapse. There is no lack of cases in which recovery has followed after the abdomen has been completely transfixed by sword, bayonet, or fire-arm missile; or after a penetrating wound followed by the passage of the instrument by the anus. Travers[1] has collected many such, in some of which the patients were up and about by the eighth or tenth day. Wiseman inferred that in these cases the weapon "passeth through the body without wounding any considerable part." Garangeot thought likewise. But thanks to experiments and accurate pathological observations, we see now, as John Bell[2] wrote, "how this is to be explained; for we know that in a thrust across the abdomen, six turns of intestine may be wounded, and each wound may adhere; adhesion, we know, is begun in a few hours, and is perfected in a few days; and when it is perfect, all danger of inflammation is over; and when the danger of inflammation is over, the patient may walk abroad; so that we may do just as old Wiseman did in this case, 'bleed him, and advise him to keep his bed and be quiet.'" It is surprising that John Hunter, though he recognized the fact that wounded intestines quickly adhered to one another, "especially near to the wounds;" and though he described in detail the autopsy of a case in which the third part of the duodenum and three coils of jejunum had been penetrated, without any extravasation occurring, by a ball fired in a duel in Hyde Park, on September 4, 1783, should yet have concluded, when describing another case in which the ball passed through from front to back of the abdomen, that none of the intestines were wounded, because there was no blood in the stools, and no symptoms of extravasation of the contents of any viscus. It is quite as surprising to read, that a case in which a minié ball of large size passed directly from rear to front through the belly, almost through the centre of the intestines as they lie coiled up in the abdomen, and in which "it is very certain that the ball passed in a direct line and was not deflected," but in which no fecal matter was discharged through either orifice and no pus by the rectum, should be cited as proof "that Malgaigne's denial of penetrating wounds of the abdomen without visceral injury can only be accepted in a restricted sense."[1]

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[1] Op. cit., p. 133.

[2] Travers, op. cit., p. 98, Experiment O.

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[1] Op. cit., pp. 29–35 and 59–65.
[2] Op. cit., p. 330.

Symptoms.—These vary in different cases and in different constitutions, from those of mere temporary shock, with the mildest possible form of local adhesive inflammation, to all the symptoms of a most severe and widespread peritonitis. This may be most insidious in its onset; three, four, or even eight days may elapse after a stab in the abdomen, involving the intestines in more than one place, without any symptom being evinced; then obstinate vomiting suddenly sets in, and the patient is carried off in a few days by peritonitis.[2]

When effusion into the abdomen occurs, the course of the case is generally that of the most acute and fatal form of traumatic peritonitis. When effusion takes place externally, the symptoms may be limited to more or less shock and local tenderness, followed within a few days by recovery with a temporary fistula. When neither internal nor external effusion occurs, the patient may recover without ever having had any symptom indicative of a severe abdominal wound; or, on the other hand, severe peritonitis accompanied by high fever, jaundice, diarrhœa, bloody urine, bloody stools or vomit, or perhaps by the passage, within a period of from a few days to three or four weeks after the injury, of a bullet or other foreign body by the rectum, or of some fragment of clothing by the urethra—one or other of these symptoms—may give the case a very grave aspect for a time at least, though recovery will ultimately follow. Suppuration or sloughing about the external wound may continue for some weeks, but healing after a time will take place by means of granulations.

Diagnosis.—Unless it is followed by the escape externally of the contents of the viscus, a penetrating wound, with injury to an organ, can only be diagnosed from a simple penetrating wound if blood be passed by the rectum, or vomited, or voided with the urine; or if the missile, or some foreign body, such as a piece of clothing carried in by the weapon, is passed through one of the natural outlets of the body; or, in the case of the bladder, if at the time of the injury the bladder is known to have been full, and afterwards nothing but blood, or blood with a little urine, can be voided or withdrawn. A visceral wound may be fatal by hemorrhage, causing syncope, or oppression of the sympathetic by the weight of the effused blood; but there are no means of knowing the exact source of the bleeding; it may be from a deep vessel in the parietes, or from a wound of either of the solid or hollow viscera. If effusion of the visceral contents occurs into the abdominal cavity, but not outwardly, and inflammation is excited, we cannot even then be quite sure that the peritonitis has been set up by effusion, and not simply by the wound of the parietal peritoneum. If effusion of bile, urine, or fecal matter has taken place to any extent, the immediate symptoms will be distressing vomiting and nausea, acute pain, and restlessness, and some or all of the other symptoms characteristic of traumatic peritonitis; but this is all that can be said to be the invariable result of these effusions. We know that many wounds which have positively involved the viscera are not followed by effusion, but rapidly heal by adhesive inflammation; we know further that a small quantity of bile or feces, especially if very gradually effused, may be shut away from the general peritoneal cavity and become encysted, and that recovery after abscess may follow. Such cases should make us cautious in our treatment, and forbid unnecessary surgical interference. Further, we know that even large quantities of healthy urine may be for a time in contact with the peritoneum without causing fatal peritonitis, or may be shut up in a circumscribed space formed by adhesive inflammation and effusion of plastic lymph from the surrounding parts. But, lastly, we know that the common consequence of visceral effusion is death; though from the post-mortem conditions of cases, we are encouraged to believe that in many, had the diagnosis of extravasation been made and the abdomen explored, the effused matter might have been completely removed, the wound in the viscus closed by sutures, and thus a chance of recovery afforded. It is to be regretted, therefore, that our means of diagnosis of fecal or other extravasation are not more perfect; and the attention of surgeons should be directed to every circumstance which will tend to make them more so.

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[1] Med. and Surg. Hist. of War of Rebellion. Second Surgical Volume, p. 204.

[2] Two cases are recorded by La Motte and quoted by Travers (op. cit., p. 78).

Prognosis.—There are two sources of apprehension special to these wounds, viz., lest extravasated blood should conduce to the effusion of the contents of the viscera into the abdominal cavity; and lest the contents, when effused, should lead to fatal peritonitis. That effusion is a necessary, or even the ordinary, result of visceral wounds, both theory and experience disprove; and that reparation may be looked for in such wounds, the records of the profession indubitably show. These records further show that, whereas some cases have recovered so well and rapidly as to lead such men as Wiseman and others to believe that the viscera had altogether escaped injury; in others the inflammation has been so general and severe as to render the patients' recovery a surprise to their attendants. If the contents of the wounded viscus escape through the external wound, the prognosis is less unfavorable than when they escape internally; recovery with a fecal fistula, or a false anus, may follow; but the opening will, most probably, ultimately close.

Treatment.—If there be no evidence or suspicion of effusion from any of the organs, the external wound should be closed and treated in the manner recommended for "simple penetrating wounds." If there is escape of some of the contents through the external wound, this should be cleaned and lightly dressed with some warm, weak, carbolic-acid fomentation; but its edges should not be brought together, and the discharge should be permitted to flow freely into the dressings, or, through an opening in them, into some carded oakum, or a pad of peat-moss. If the case is seen within an hour or two, and through the external wound the stomach or intestine, or other hollow viscus, is seen to be wounded, the external opening should be enlarged sufficiently to allow of the visceral wound being closed by suture; and at the same time, if effusion into the abdominal cavity has taken place, scrupulous care should be given to the "toilette" of the peritoneum before closing the external wound. Again, if severe hemorrhage into the peritoneum occurs from wounded mesentery, omentum, or bowel, abdominal section for the purpose of removing the blood-clot, ligaturing the bleeding vessel, and suturing the visceral wound, will in some cases be followed by a successful result; though, of course, if the source of bleeding be either the vena cava, aorta, or some large vascular surface such as a ruptured liver, it can hardly be expected that any good can follow from an exploratory operation. Probing and dilatation of the wound, except as part of some definite operation, cannot be too strongly condemned. The general treatment is simple: There should be complete abstinence from solid food, and for at least ten days or a fortnight after the injury only small quantities of nutritive fluids, given at definite intervals, should be allowed. Thirst may be slaked with small fragments of ice. The bowels should be kept perfectly quiet, and if their relief be demanded, this should be secured by enemata. The recumbent position, with the knees propped up by a pillow, should be rigorously observed. Opium or morphia should be given freely and often, so as to keep the mind and body gently under its influence; subcutaneous injections of morphia, or morphia suppositories, are good forms for the administration of the drug, and serve, besides, to relieve sickness, which is so commonly a troublesome symptom. The state of the stomach is a more important guide than the pulse. Travers says: "The intimate connection and lively sympathy subsisting between the digestive and vascular systems render the pulse an equivocal if not fallacious criterion of the morbid changes which are to ensue. But if the stomach is quiet we have little to fear. . . . How, then, shall the irritation of this organ be appeased, which, if it continues, is a never-failing omen of destruction? I would answer by the reduction of the system; early, free, and repeated blood-letting, general and topical, is the main remedy upon which I place reliance."[1]

In most of the instances of recovery after severe inflammation, blood-letting has been early and freely resorted to, and many high authorities might be quoted in favor of this practice. Whilst sickness and intense pain continue, the state of the pulse need not, as Travers repeats, deter the surgeon from bleeding, as the apprehension of reducing the power of the system below the means of reparation is futile. The general treatment of these injuries is concisely stated by Dionis:[2] "Les saignées faites les unes près des autres, la diète exacte, les fomentations émollientes sur le ventre, sont presque les seules ressources de l'art, soit pour prévenir ces symptômes, soit pour y remédier."[3]

Penetrating wounds of the stomach vary in gravity according as there is or is not effusion of its contents; or, if effusion occurs, according as it takes place into the cavity of the abdomen or through the external wound. Cases have been recorded of death from wounds of the stomach unattended by effusion; but, as a rule, such wounds are the most likely to recover without peritonitis, and, except in the case of gunshot wounds, without fistula. In gunshot wounds, unattended at the time by effusion, a fistula may subsequently be formed by the separation of sloughs, after the adhesion of the stomach to the parietes. Effusion is sometimes prevented, though the opening be large, if the wound passes obliquely through the different coats of the stomach; and immediate and incessant vomiting, by clearing the stomach of all its contents, sometimes obviates their escape through the wound. It has occasionally happened that a small amount of material has escaped through the opening in the stomach, and, having been circumscribed by inflammatory adhesions, has afterwards been discharged externally by means of suppuration.

When the contents of the stomach escape through the external wound, there is the clearest possible evidence of the nature of the injury. Such a case is less favorable than those in which there is no effusion at all, but very much more favorable than those in which the escape is into the abdominal cavity. Whatever is taken by the mouth may be discharged almost at once, and almost unaltered, through the wound. Peritonitis, more or less severe and more or less general, may arise, and a fistula, for a time at least, is pretty certain to follow.

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[1] Op. cit., pp. 75, 76.

[2] Cours d'Opérations de Chirurgie, revue par G. de La Faye, p. 84. 1751.

[3] [Bleedings practised one after another, absolute diet, and emollient fomentations on the belly, are almost the only resources of our art, whether to prevent these symptoms or to remedy them.]

When the contents of the stomach escape into the abdominal cavity, there will be the same urgent symptoms as attend extravasation of feces, bile, or urine. The chief diagnostic symptoms of these hopeless cases, according to Travers, appear to be:—

> (1) Sudden, most acute, and unremitting pain, radiating from the scrobiculus cordis, or the navel, to the circumference of the trunk, and even to the limbs. A peculiar pain, the intensity of which, like that of parturition, absorbs the whole mind of the patient, who, within an hour from the enjoyment of perfect health, expresses his serious and decided conviction, that if the pain be not speedily alleviated he must die.
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> (2) Coeval with the attack of pain, remarkable rigidity and hardness of the belly, from a fixed and spastic contraction of the abdominal muscles.
>
> (3) A natural pulse for some hours, until the symptoms are merged in those of acute peritonitis, and its fatal termination in the adhesive stage.[1]

There are, besides, extreme anxiety, collapse, cold sweats, and what John Hunter has described as a "sleepy languidness in the eye, which makes one suspect something more than a common wound."

In every form of stomach-wound there may be vomiting of blood, and blood may also escape through the external wound.

Diagnosis.—The situation of the wound, the vomiting of blood, and especially the escape of chyme, or fluids, or particles of food recently taken, are the indications of wound of the stomach. When we have only the first of these three means of judging, the diagnosis must be uncertain.

Prognosis.—As Hennen has observed, these cases are extremely dangerous, though not always mortal. Punctured and small incised wounds are *cæteris paribus*, the most hopeful; lacerated and gunshot wounds the most fatal. Alcock gives only one case of recovery from wound of the stomach out of 3000 cases of gunshot wound. Wounds near or at the curvatures are attended by more danger from hemorrhage than wounds on the surfaces; and hemorrhage is here very difficult to stop. Recoveries after wounds of the stomach are recorded by Thomson, Guthrie, Hévin,[2] William Scott[3], Archer, and McCarterat; and Abernethy relates a case in which, after a gunshot wound of the stomach, adhesions were formed, the stomach sloughed, and its contents were received into a pouch which gradually extended till it broke at the groin. The fluids which were taken by the mouth could be drawn off through the resulting fistula, by simply removing a little cork, which the patient, a Frenchman, was in the habit of wearing in the opening, and removing for the purposes of public exhibition.

The results of wounds of the stomach which are not fatal, are (1) adhesion of the wound in the stomach to the peritoneum of the parietes, or of some other organ, and the closure of the wound in the abdominal walls; (2) formation of a fistulous opening, which may remain permanent for the rest of life, or may close after an interval varying from a few days to 27 years (Wencker's case).

Treatment.—Total abstinence from all food and drink, for a time; enemata of beef-tea and egg, with or without opium, as required; the utmost quietude; and the relaxation of the abdominal muscles by position, are the best means for guarding against extravasation. If extravasation have not already occurred, the external wound should be closed by sutures; and in certain cases, before doing so, it will be possible to see the wounded viscus, and to draw it out through a large wound, stitch up the opening in it, and return it. Percy and M. Rubstral did this successfully. In exceptional cases it would be justifiable to enlarge the wound in the parietes for this purpose. When inflammation sets in, the treatment should be that recommended for traumatic peritonitis.

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[1] Med.-Chir. Trans., vol. viii. pp. 231 *et seq.*

[2] Mém. de l'Académie de Chirurgie.

[3] Med. Communications, vol. ii. p. 78.

Penetrating Wounds of the Intestine.—The symptoms of wounded intestine are commonly more severe, and extravasation more frequent, in lesions of the small than in those of the large bowel. This is owing to the more delicate organization of the small bowel, to its more fluid contents, to its nearer situation to the stomach and the point of entrance of such important secretions as the bile and pancreatic fluid, and to the fact that when the effusion takes place from an opening high up in the small bowel, even though the escape is entirely external, death must ensue from marasmus. The close connection of the duodenum and upper end of the jejunum with the sympathetic ganglia and nerves, probably explains why wounds of these parts of the gut are so commonly attended with extreme anxiety and shock.

Symptoms.—The severity of the general symptoms is not by any means always a measure of the extent of the injury, or of the gravity of the case. It is the same in injuries of the abdomen as in those of other regions: some persons suffer much more severely, and reaction in them is much longer delayed than in others. As a general statement, however, the danger of the case will depend, first, upon the occurrence or non-occurrence of extravasation of the intestinal contents into the abdominal cavity, and this again will depend greatly upon the size and character of the wound, a point to which reference has already been fully made; secondly, upon the persistence of vomiting, which is an unfavorable condition, and one which, unless it can be controlled, is sure to lead to a fatal end; thirdly, upon hemorrhage; and fourthly, upon the character of the supervening peritonitis. When there is no escape of chyle, feces, or fecal gas, through the external wound, both the local and general symptoms are equivocal. Perhaps the most characteristic signs are the peculiar griping pains in the abdomen, the urgent thirst, the desire for cool air, the nausea and vomiting, the bloody stools, and the tympanites. Dr. Gross lays great stress on this latter symptom, which he thinks has not been sufficiently insisted upon by systematic writers, and which, from being often present when the other symptoms are absent, may be regarded in some degree as pathognomonic. Jobert, too, thinks it the most valuable and positive sign of a wound of the intestine that we can have, except of course the egress of intestinal contents. Both Dr. Gross and Jobert relate several instances in which the diagnosis was made by this symptom alone. The tympanites occurs from a few minutes to several hours after the accident, and is always accompanied with tenderness on pressure and difficult respiration. I can myself testify to the importance of this symptom as indicating the giving way of the bowel, especially of the cæcum or large intestine, in cases of intestinal obstruction; but at the same time it is often a most prominent symptom in acute peritonitis where the intestine is unruptured, and it may also arise as a consequence of simple contusion, from intestinal palsy following on concussion of the ganglionic nerve-centres. Neither is tympanites an accompaniment of all traumatic injuries of the intestine, for, as Dr. Gross remarks, it does not take place if the opening is very small, and if effusion is prevented by the protrusion of the mucous membrane, or otherwise. The discharge of blood by the anus or by the mouth will vary according to the part of the intestine wounded. The quantity discharged sometimes amounts to many ounces, or even pints, and its color depends upon the length of time it has been retained in the bowel. It may begin to pass off at once, or not until seven or more hours after the accident; and it may continue to pass for some days. It must be borne in mind, however, that the discharge of blood from the intestine attends other injuries than actual wound of the bowel. Rarely, after gunshot wounds, the bullet has been passed off by the stools. M. Chenu has recorded one such instance. In almost every case there is nausea, with or without vomiting, beginning within a few minutes of the injury; these symptoms persist sometimes for days, with great obstinacy, even until death comes to the relief of the sufferer. The pain is generally of a griping character, but it may be of a dull, aching kind; it is almost always aggravated by coughing, or by a deep inspiration, or even by the pressure of the bedclothes.

If there be extravasation of the contents of the bowel into the peritoneum, death will certainly occur, unless the amount extravasated be very small, and escape so slowly as to allow of its being inclosed by plastic lymph. Sometimes death takes place in cases of extravasation within a few hours from the first shock of the accident. More commonly it is caused by acute peritonitis, the symptoms of which do not usually extend over forty-eight hours; they need not be here recapitulated. If the extravasated matter has become encysted, an abscess generally forms and is evacuated, or the patient, after weeks or months of suffering, is worn out by chronic peritonitis or exhausting discharges.

If there be extravasation through the external wound, the adhesive process may, in a few hours, seal the edges of the intestinal to those of the parietal wound, and the peritoneal cavity may thus become closed. Much temporary relief is obtained by this external escape of the intestinal contents: abdominal tension is taken off; inflammation is lessened, and after a few days, under favorable circumstances, subsides altogether; the wound granulates; and if the intestine can resume its natural function, and the part injured be not too near the stomach, life is preserved, and that, too, without the complication of a false anus or fecal fistula. External effusion is, however, prevented by the obliquity of the wound in the different layers of the abdominal parietes, by the intestinal wound not being opposite to the parietal wound, or by the partial closure from muscular contraction of the parietal wound. The passage of the contents of the large bowel through the external wound is more easy than that of the contents of the small gut, owing to the greater fixity of the large intestine.

Diagnosis.—This lesion ought to be suspected if nausea and vomiting, accompanied with faintness, great restlessness, extreme anxiety, cold sweats, colicky pains, and tympanites, follow immediately or soon after a penetrating wound of the belly. The suspicion is confirmed if, some time after the setting in of these symptoms, blood is vomited or passed by the rectum. If there is escape of the contents of the intestine through the external wound, the diagnosis is of course positive.

Prognosis.—Though essentially dangerous, these wounds are not necessarily fatal; and no absolute rule can be formulated in respect to their prognosis, except that they must always be regarded as amongst the gravest accidents, and likely to be followed by the worst results. That some persons die from the shock of even a small wound, whilst others recover from the most desperate injuries to the abdominal contents, has been already stated, and is well known to surgeons. It is possible that in some penetrating wounds, as in some cases of blow upon the epigastrium, death is produced by the mere shock to the sympathetic nervous system. On the other hand, the abdomen may be transfixed through and through, and the viscera wounded at many points, and no bad consequences follow. Every work on wounds of the intestine contains the records of one or more such cases. If effusion occurs into the peritoneal cavity, the prognosis is certain death, except under the condition of slight and slow extravasation. If the effusion is external, death may occur from peritonitis or marasmus; or recovery may follow with or without a fecal fistula or false anus. Diffuse peritonitis, once established, is fatal; circumscribed peritonitis, when localized in the immediate seat of the wound, is often protective only, not destructive. Whether there be effusion of intestinal contents or not, hemorrhage may occur into the peritoneal cavity, and death may follow in a short time from the loss of blood, or from peritonitis caused by the clotted blood acting as a foreign body; or the clot may be absorbed or become encysted, and the patient recover.

Treatment.—Where no extravasation whatever occurs, the case must be treated as one of simple penetrating wound of the parietes. If feces escape, the wound must be left open, and in as dependent a position as possible. Entire rest, and abstinence from food, from purgatives, and from all forms of drink, must be enforced. Thirst must be slaked by small fragments of ice, or by submerging the patient in the continuous warm bath. Opium or morphia must be given, either by the rectum or as a subcutaneous injection, to allay pain and check peristaltic action. It is still an open and unsettled question whether it is proper to enlarge the wound with the object of applying sutures to the wounded bowel. If effusion has not taken place, and the visceral wound is small, such a step could but add to the danger by the disturbance necessitated by the search for the wound, which might be unsuccessful in the end. If effusion has taken place some time before the patient is seen, inflammation will probably have set in, and the parts will have become glued together, or will have passed beyond the reach of repair. Again, after transfixion of the belly, if the viscera are wounded in several places, interference is hopeless, if not mischievous. But when there is clear or good presumptive evidence of extravasation, from a single or at most a double wound—or if the wound in the intestine can be seen through the external opening—there can be no question that the wisest plan is to close the visceral wound by suture.

Dr. Otis[1] remarks:—

> "That enterorraphy is the proper treatment for punctured or incised wounds of the intestines, with protrusion, is now questioned by none; that in similar wounds, without protrusion of the small intestine, and of parts of the large intestine covered by the peritoneum, it is proper to enlarge the external wound and find the wounded part, and secure it by enterorraphy, a mass of affirmative evidence has been brought forward. The experience of the war does not enable us to demonstrate the benefits of applying the same principles to shot-wounds;" but he adds (p. 128), "already interference contrasts favorably with the do-nothing system. Reflection . . . leads unavoidably, in the writer's opinion, to a conviction of the propriety of incising the abdominal wall when necessary, in order to expose and sew up the wounded gut concealed within the cavity, whether divided by a cutting instrument or by shot. The obstacles to success are obvious; but it is a mortal peril which demands an extreme remedy."

Should peritonitis occur, the treatment appropriate for that complication must be followed.

Gunshot wounds of the stomach and intestine are not necessarily attended with effusion into the abdomen, nor externally through the wound. When effusion does occur, it may be either primary, or secondary, owing to the separation of the sloughs along the track of the bullet. The period of the separation of these sloughs may be at any time from the eighth to the fourteenth day. The great difference between primary and secondary effusion, is that the primary is generally into the cavity of the abdomen, whereas the secondary extravasation is very commonly at the external wound, adhesive inflammation having sealed the peritoneal cavity from the wounded part of the viscus, and the wounded viscera to one another. In this way, if two or more coils of intestine have been penetrated by the shot, they become united to one another around about the wounds, and if sloughs subsequently separate, they fall into the interior of the bowel and are passed off with the stools. As John Hunter says, in describing the case of a young man who recovered without an artificial anus, after being shot through the abdomen by three balls:—

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[1] Med. and Surg. Hist., etc., Part II., Surg. Vol., p. 124.

> I concluded that whatever cavities the balls had entered, there the surrounding parts had adhered, so that the passage of the ball was by this means become a complete canal, and therefore that neither any extraneous bodies that had been carried in with the balls and had not been carried through, nor any sloughs that might separate from the sides of the canal, nor the matter formed in it, could now [about a fortnight after the infliction of the wound] get into the cavity of the abdomen, but must be conducted to the external surface of the body, either through the wounds, or from an abscess forming for itself, which would work its own exit somewhere. But this conclusion was supposed to be too hasty, and soon after a new symptom arose which alarmed those who did not see the propriety of my reasoning, which was some feces coming through the wound; this new sympton did not alter my opinion respecting the whole operations of nature to secure the cavity of the abdomen, but as I saw the possibility of the wound becoming an artificial anus, I was sorry for it.

Penetrating gunshot wounds of the abdomen are for the most part fatal. Alcock says that of 18 cases in the Prussian war, between 1836 and 1837, all ended in death; and Poland states that during the revolution of Paris, in July, 1848, there were a great number of such wounds, and for the most part fatal. Matthew records that in the British army in the Crimea—

> Where penetration of the abdominal cavity by gunshot injury was considered to be beyond doubt, death was the rule, recovery the rare exception, only nine patients having survived out of 120 where this was believed to have taken place, and even of this small number some of the cases were not unequivocal.

M. Chenu states that, in the French army in the same war, out of 121 penetrating shot wounds of the abdomen 111 died; and as regards the Italian campaign in 1859, he says, "penetrating wounds, very grave usually, gave a great mortality in the field, and an equally great mortality in the hospitals."

Writing of *wounds of the viscera within the peritoneal cavity* during the American War of the Rebellion, Dr. Otis says that "he has sought to analyze the different varieties of this group, and to estimate the comparative mortality of wounds of the liver, spleen, and kidneys, and of the alimentary canal; and it is believed that those who will take the trouble to examine the evidence, will be unable to resist the conclusion that, while recoveries from wounds of the liver are more frequent than was formerly believed, and wounds of the spleen and kidney occasionally, and those of the colon frequently, terminate favorably, the rarity of recoveries from wounds of the stomach and small intestine treated without operative interference is extreme."[1]

In the numerical statement of the cases of penetrating wound of the abdomen during the American War (Table IV.), out of 79 cases of gunshot wound of the stomach, 19 ended in recovery; and of 653 cases of gunshot wound of the intestine, 118 ended in recovery, and in 51 the results were unknown. But of these cases of recovery after wounds of intestines, the largest group includes cases of perforation of the large intestine *in parts uncovered by peritoneum*, and there are only 5 cases of recovery after gunshot wounds of the small intestine.

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[1] Med. and Surg. History of War of Rebellion. Part II., Surgical Volume, p. 205.

Dr. Otis tells us that musket-balls commonly divide a considerable portion of the calibre of a small intestine; carbine or pistol-balls sometimes make two perforations of its walls; and occasionally a small projectile may perforate the intestinal wall at a single point, and lodge within the gut. In such cases as the last mentioned, the usual eversion of the mucous tunic ensues, and the appearances are not to be distinguished from those resulting in a true punctured wound, inflicted by a sharp-pointed instrument. He also considers it to be characteristic of shot-lesions of the intestines, that the injury to the serous, is less extensive than that to the mucous and muscular tunics. Though a ball completely traversing the abdomen has been known to wound the small intestine no less than sixteen times in its passage, it is not, Otis thinks, very common for more than two convolutions to be wounded, or for the wall of the small intestine to be perforated in more than four places. Dr. Gross[1] records a case in which a pistol ball perforated the ileum, jejunum, duodenum, and arch of the colon, making thus eight separate orifices; and many other such cases of multiple injury are on record.

In the treatment of penetrating wounds of the abdomen, as has been stated above, much difference of opinion has been expressed respecting the propriety of abdominal incision for the removal of extravasated matter and the application of sutures to the intestine, or, in other words, the practice of enterorraphy. It seems to me, however, that sufficient distinction is not always made by writers between ordinary incised or punctured wounds on the one hand, in which it is probable that the intestine is wounded at only one or at most two points; and cases of gunshot or other contused wounds on the other hand, in which it is almost certain that more or less sloughing must follow about the edges of the wound, and in which the intestines are wounded in several points which would have to be sought for at the risk of dangerous and prolonged disturbance and manipulation, and some of which, in all probability, would be overlooked by the eye of the surgeon, though the officious inquisitiveness of his fingers might cause them to become the seat of effusion. Poland, with the evidence before him of that brilliant epoch in military surgery when Larrey, Hennen, and Guthrie, were the guiding lights, condemned the practice and recommendations of Baudens and Legouest; Neudörfer and F. H. Hamilton have more recently condemned any surgical interference with shot-wounds of the intestines; and after a careful perusal of the marvellously full and exhaustive chapter on Injuries of the Abdomen in the Medical and Surgical History of the War of the Rebellion, in which enterorraphy is advocated, I entirely coincide with the opinion of that revered and veteran master of surgery, Prof. Gross, who, while heartily endorsing the propriety of exploratory incision and of enterorraphy in cases of ordinary intestinal wounds without protrusion, regards such measures as unlikely to be of benefit in shot-wounds of the bowels, because such lesions are commonly multiple, and, I would add, always of the nature of contused wounds.

The experience of the American War affords nothing in proof of the benefits of laparotomy and enterorraphy in gunshot wounds, and the inference is, that what Thomson[2] wrote after the battle of Waterloo, might be equally said of the surgeons engaged in that war: "In these cases, the more that is left to nature in the process of reunion, and the less her operations are interfered with, the greater will be the chance of ultimate recovery." I would, however, advise the reader to peruse for himself Dr. Otis's very exhaustive and masterly summary of the subject.[1]

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[1] System of Surgery, vol. ii.

[2] Report of Observations made in the British Military Hospitals in Belgium, etc., p. 106. Edinburgh, 1816.

Penetrating Wounds of the Liver.—Punctured and incised wounds of the liver are much less frequent than subcutaneous ruptures of that organ. In the annals of Surgery about sixty cases of stab-wound of the liver are definitely described, and Ludwig Mayer has collected twenty-one instances of recovery from such injuries. They rarely come under the notice of the surgeon. The surgeon, however, occasionally inflicts such wounds upon his patients, as in the treatment of hydatid cysts and abscesses of the liver. Hemorrhage is one of the chief dangers, but there is good reason for thinking that in the case of clean incised wounds it is controllable, and has been overrated. Slight and superficial wounds are followed by recovery, but when deep, and if attended by any large amount of hemorrhage into the abdominal cavity, they are speedily fatal.

Symptoms.—These are hemorrhage, and perhaps a discharge of bilious matter from the wound—or evidence of internal hemorrhage—accompanied by a dull pain, which, according to Boyer, extends to the shoulder and larynx if the convex surface be wounded, and an acute pain about the ensiform cartilage if the under surface be injured; vomiting, hiccough, and labored breathing; followed by occasional rigors, tympanites, heartburn, and, at a still later period, by more or less delirium. If the patient survives many hours, the functions of the stomach and bowels are disturbed; and if general hepatitis occurs, jaundice of the skin and bile-pigmented urine appear, and great itching of the surface will follow.

Diagnosis.—The position and direction of the wound will greatly assist in arriving at a correct diagnosis. If the weapon have entered between the lower intercostal spaces of the right side, the liver must be involved, unless the wound be limited to the parietes; and if the wound be below the ribs and its course horizontal, the liver may be implicated, as the organ may extend to a very low position on the right, owing either to enlargement or displacement.

The prognosis is very unfavorable if the wound be a severe one; as has been stated, slight wounds are often recovered from.

The *treatment* does not differ from that described for rupture of the liver; the wound of the parietes adds but little to the danger, and in comparison with the visceral injury is unimportant. If the external wound be large, it should be held together by sutures; but if bile or blood be escaping through it, it must be kept open. Should peritonitis occur, it must be treated as already described.

Gunshot wounds of the liver vary from slight groovings, or laceration of the peritoneal investment only, to long perforations and lacerations complicated with the presence of splinters of ribs, or fragments of clothing, or other foreign bodies; from slight fissures or limited contusions, to extensively pulpefied or mangled ruptures. These differences depend greatly upon the velocity of the projectile, as well as upon its size and direction. At close ranges, the missile inflicts great destruction, and mangling appears to be the all but uniform effect of even small carbine or pistol shots upon the liver. (Otis.) The first dangers of these wounds are shock and primary hemorrhage, and if the patient escapes these, he will be likely to die of secondary hemorrhage, peritonitis, or abscess of the liver. Such injuries, however, even when very serious, are not necessarily fatal. Dr. Otis records 25 recoveries out of 59 cases of gunshot wound of the liver, uncomplicated with lesions of other organs; and 37 recoveries out of 111 cases of shot-wound of the liver complicated by various grave injuries either of the abdomen or other regions. Wounds of the liver are very frequently associated with fractures of the lower ribs and spine, and with wounds of the diaphragm and other viscera at the upper part of the abdomen. General hepatitis, demonstrated after death as well as clinically, was present in only a small proportion of the cases which occurred in the war of the Rebellion. As in gunshot wounds of the lung, general pleurisy and pneumonia are the exceptional, not the usual consequences, the inflammatory changes being as a rule limited to the immediate vicinity of the bullet track; so in the case of shot-wounds of the liver, inflammation is localized, and partial hepatitis the result. Jaundice, though a constant symptom of general hepatitis, is rarely present in inflammation of small areas of the liver.

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[1] Med. and Surg. History of the War of the Rebellion. Part Second, Surgical Volume, pp. 123–128.

Penetrating wounds of the gall-bladder and ducts are extremely rare on account of the small size and protected situation of those organs. They are very fatal on account of the irritating action of the bile upon the peritoneum, over which it diffuses itself rapidly. John Bell,[1] after speaking of wounds of the bladder, says: "The wound of the gall-bladder is like this; for its fluid is stimulating in a still higher degree, and the patient very seldom escapes the quick and deadly inflammation; the urine and the bile act like poisons thrown into the abdomen, the patient dying a most miserable death." Again, he says: "The bile is the highest stimulus, the urine next, the food and the feces are less irritating, and the blood least of all; perhaps it is according to this order that the danger of these wounds should be calculated, effusions of bile being the most dangerous."[2] That the intensity of peritonitis from effusion of bile has been exaggerated, is shown by the experiments on animals of Höring,[3] Herlin,[4] and Campaignac,[5] and by some of the recorded cases of extravasation of bile in the human subject. Bohn, in 1689, and Kaltschmidt, in 1735, held that bile might be effused into the abdomen without any immediate danger, but a century later, Sabatier, who had an opportunity of noticing the symptoms in a case of wound of the gall-bladder, regarded fatal peritonitis, after a few hours or days, as the necessary result of extravasation of bile into the abdominal cavity. Sabatier's view is still the prevailing one, but it requires modification, both as to the intensity of the inflammation and the rapidity of its course.

Symptoms.—These are great abdominal tension and pain, especially in the right hypochondrium, with small, frequent, contracted and intermittent pulse, difficult respiration, sleeplessness and great restlessness, cold extremities and pinched, pale countenance, and sometimes jaundice, hiccough, and nausea. Dr. Stewart[6] communicated to the Royal Society, of London, a case of wound penetrating the abdomen and fundus of the gall-bladder, without doing any material injury to the adjacent parts:—

The abdomen was immediately distended to an extreme degree, and the amount of tympanites did not afterwards diminish. There was complete constipation in spite of purgatives and clysters. A good deal of liquid nourishment was given; anodynes failed to procure a moment of sleep, and there was incessant restlessness till the patient's death, which happened in a week. After death the intestines were found much distended, the gall-bladder quite empty, and a large quantity of bile extravasated.

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[1] Op. cit., p. 356.

[2] Ibid., p. 358.

[3] Diss. sistens experiment. de mutationibus quas materiæ in cavum peritonei injectæ subeunt. Tübing., 1817.

[4] Journ. de Méd., t. xxvii. p. 463.

[5] Journ. Hebdom., t. ii. p. 210.

[6] Philosophical Transactions, No. 414, p. 341.

Sabatier's[1] case was very similar to Dr. Stewart's:—

The patient died on the third day, a few hours after a blackish-green, odorless fluid, supposed to be pure bile, had been drawn off through a canula, introduced into the right iliac region. On opening the body, the bowels were found prodigiously distended, and the gall-bladder shrivelled and almost empty; in its fundus was a wound about a line and a half long, corresponding to a similar wound in the peritoneum. The instrument had penetrated between the third and fourth false ribs, and had glided from above, downwards and forwards between the cartilages of the ribs, until it had reached the fundus of the gall-bladder.

Waton[2] gives a fatal case from puncture of the cyst by a bayonet; and Sir Astley Cooper gives another, in which the bayonet entered just below the margin of the ribs, on the right side; the wounded man fainted and fell, and on recovering consciousness experienced agonizing pain in his abdomen, which became extremely tense and tender, and he died in thirteen hours. The gall-bladder was found to have been penetrated, and bile was extravasated into the abdomen; and wherever it had rested the peritoneum was highly inflamed.

Wounds of the hepatic, or cystic, or common duct, would doubtless be attended with the same symptoms as wounds of the gall-bladder, but they must be extremely rare. I do not know of any case on record of penetrating wound of the ducts, except from gunshot. In a case of gunshot perforation of the right lobe of the liver, with division of a branch of the hepatic duct,[3] bile was discharged at intervals from the wound, and the man died of general peritonitis, with adhesions, on the forty-fourth day.

In cases in which the gall-bladder has been wounded by gunshot, the liver has been injured too. In one instance[4] the ball passed through the cartilage of the ninth rib, the quadrate lobe of the liver, the gall-bladder, ascending colon, and right kidney, and made its exit near the twelfth dorsal vertebra; the shock was not severe, but in a few hours there were great pain and tension of the abdomen, and death occurred in fifteen hours from the time of the injury. The peritoneum was found filled with blood, and intense peritonitis had already been established. In two other cases,[5] in which both liver and gall-bladder were injured, the patients lived five and eight weeks respectively. In both there was discharge of bile from the wound; in one there was jaundice of the skin and conjunctiva, and in the other severe diarrhœa existed for the whole five weeks of life. This last symptom is noteworthy, as obstinate constipation is mentioned by Poland and others as a symptom of injured gall-bladder.

Prognosis.—The only known instance of recovery after gunshot wound of the gall-bladder, is the case recorded by Parroisse,[6] as having occurred to M. Huttier. It was that of a military man, who received a shot-wound in the internal and lateral part of the right hypochondrium, and who died two years subsequently of chest-disease, when a ball was found in the gall-bladder, on which, however, there was no trace of a cicatrix.

Treatment.—These injuries must be treated like other penetrating wounds of the abdomen with lesion of the viscera. There are reasonable grounds for thinking that in wounds, as in ruptures, of the gall-bladder, it is probably not as much the original escape of bile which brings about the fatal result, as its continual filtration into the peritoneal sac; hence the question arises, as Campaignac pointed out, how far surgery can afford any aid in preventing the further escape of bile in this kind of injury. To this end he advised ligation of the ducts, and Herlin, removal of the gall-bladder.[1] If it happened that the cyst or one of the ducts alone were injured, laparotomy, followed by the stitching up of the wound in the cyst or the ligation of the duct, might be followed by a good result, and would be certainly worthy of trial, especially as these injuries are so commonly fatal. But if the liver also were wounded, and some large branch of the bile-ducts within it laid open—or if, as in the case above referred to, several other important viscera were wounded also—no good could possibly follow from such an operation.

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[1] Médecine Opératoire, tome i. p. 43. Paris, 1796.

[2] Journal de Méd. Milit., tome vii. p. 550.

[3] Med. and Surg. History of the War of the Rebellion, Part Second, Surgical Volume, p. 139.

[4] Ibid., p. 136.

[5] Ibid., pp. 136, 137.

[6] Opuscules de Chirurgie, p. 254. 1806.

Penetrating Wounds of the Spleen.—The spleen is less liable to penetrating wounds than the liver, owing to its smaller size; and wounds of the liver and stomach, but more especially of the thorax and diaphragm, and left kidney, are commonly met with as complications. The situation of the spleen exposes it more readily to penetrating wounds from the side and back; but when injured from the front, some of the viscera in front of it are nearly sure to be implicated. Larrey remarked that left-handed persons, in armed encounters, were most exposed to wounds of the spleen, because they presented the left side uncovered, and towards this the aim of the adversary was naturally directed.

The *symptoms* are those indicative of severe internal hemorrhage, with great tension and distension of the abdomen. The blood gravitates towards the pelvis, and may be poured out in such quantity as to give a sense of fluctuation in the abdomen. If hemorrhage is not very extensive, peritonitis sets in sooner or later, and probably carries off the patient; or localized splenitis and abscess supervene, more especially if foreign matters, such as pieces of dress, have been carried in and remain.

In Sir A. Cooper's case of a man stabbed by a dirk, the abdominal cavity was filled with fluid blood, and in the case of fatal bayonet wound recorded by Otis,[2] the abdominal cavity was full of clotted blood.

Diagnosis.—Wounds of the spleen present no distinctive symptoms, and are to be recognized only by the site of the wound, and by the supervention of faintness, coldness, and pallor, denoting internal hemorrhage, with the absence of those signs which indicate wounds of the contiguous viscera. Hunter[3] remarked: "A wound of the spleen will produce no symptoms that I know of, excepting probably sickness, from its connection with the nerves of the stomach." Nor was Dupuytren[4] able to afford any additional light on the subject.

Prognosis.—The older surgeons considered wounds of the spleen and liver, like those of the vena cava, as deadly as wounds of the heart, "so full of blood were they,"[5] though John Bell was perfectly aware that patients had recovered "where the liver must have been wounded more or less."[6] But modern instances of successful removal of parts of the spleen in man, and cases such as those recorded by Klebs and Albanese, prepare us for the conclusion that wounds of the spleen are less fatal than was formerly supposed. Hennen says: "Of wounds of the spleen I have seen a few; some of the slighter recovered, the deep invariably proved fatal." Guthrie remarks: "I have seen cases of wounds from stabs and from musket-balls, which ought to have injured the spleen, from which the sufferers recovered; and I have accidentally seen, after death, cicatrices formed in the spleen, corresponding to the external marks indicative of a former wound."

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[1] M. L'Anglas repeated M. Herlin's experiments on two dogs, and extirpated the gall-bladder after tying its neck. These two dogs recovered.

[2] Med. and Surg. History, etc., Part Second, Surgical Volume, p. 150.

[3] Treatise on the Blood, Inflammation, and Gunshot Wounds, p. 545.

[4] Leçons Orales, t. vi. p. 430.

[5] Bell, op. cit., 3d ed., p. 351.

[6] Ibid., p. 354.

Larrey saw three cases of wound of the spleen by steel weapons, all of which ended in recovery; Leveille, an instance of severe sabre wound of the spleen, which ended in recovery after intense peritonitis and prolonged suppuration. Recovery after a lacerated wound of the spleen and other abdominal injuries in a shepherd boy, aged eleven, is reported by M. Sappey.[1] Other cases of recovery after penetrating wounds of the spleen have been collected by Otis.[2] M. Legouest holds the now generally accepted view that though hemorrhage and peritonitis frequently cause death, yet recovery follows some severe splenic injuries.

Gunshot wounds of the spleen, if of a minor degree, are often repaired, and sometimes not suspected; and even extensive injuries, associated with loss of substance, are not necessarily fatal, or followed by any apparent change in the blood-making functions. Recovery may occur, though part of the bullet remain behind in the organ, as is proved by the case of the patient who died at Guy's Hospital, from Bright's disease, four years after a shot wound of the colon. At the autopsy, a piece of the bullet was found in the spleen.

Treatment.—The first indication is to check hemorrhage, the next to allay peritonitis. With the first object in view, the injured side should be strapped, as for fractured ribs, and the patient should then lie upon it. Iced drinks and ergot should be freely given, and cold should be applied externally. If peritonitis supervene, it should be met as in cases of traumatic inflammation of the peritoneum. Excision of the spleen, in some cases—in those especially in which the bleeding continues, or a large part of the organ is contused or nearly broken off—may afford the best prospect of recovery. There is no reason why splenectomy for traumatic destruction of the spleen should not be put on trial; the great mortality of the operation, hitherto, largely depends on its having been performed almost exclusively in cases of leucocythæmia or of other morbid general conditions.

Wounds of the pancreas and thoracic duct are not likely to be diagnosed, and the only interest attaching to them is this, that nearly everything about them has yet to be discovered. Beyond knowing that a portion of the pancreas may be torn from the splenic artery and its other attachments, and protrude through an external wound, and, under such circumstances, may be removed without serious consequences, we know nothing except this, that after wounds of the pancreas, death, as a rule, occurs from shock and peritonitis combined, or else from secondary hemorrhage; that life has been prolonged for twelve days or more; and that the lesions have occurred without being suspected.

John Bell's strictures on his namesake's (Benjamin Bell's) comments on wounds of the pancreas and receptaculum chyli, as on many other subjects, are well known to the student of surgical literature; and here, as elsewhere, they are based quite as much upon conjecture, instead of experience of the special matter in question, as the remarks he so vigorously attempts to refute. In justice to Benjamin Bell, it should be noticed that he says, "any injury done to the pancreas can seldom be discovered;" and if actual experience has not proved him right in supposing that division of the duct of the gland will interrupt digestion, or that the chyle or pancreatic fluid will form collections in the abdomen "the removal of which may ultimately require the assistance of surgery,"[1] it has at least, to judge by recorded cases, shown John Bell to have conjectured wrongly when he said that the pancreas could not be hurt "without a most complicated and absolutely fatal wound."[2] Otis has collected three cases of recovery from stab-wound followed by protrusion and removal of a portion of the pancreas, and gives brief notes of another case of recovery after shot-wound, under the care of Surgeon J. G. Thompson, during the War of the American Rebellion. The most interesting, and apparently the best authenticated case, is that of Caldwell.[3] In 1816, a negro man was stabbed in the left side, and "an oblong body, between three and four inches in length, was observed to be protruded between the last true and the first false rib." Being in a gangrenous state, it was removed by the bistoury, and the patient soon recovered, and was living and quite well eleven years after, "having suffered no inconvenience from the loss of the part or its unnatural adhesions." Drs. Roberts, Heard, and Caldwell made a critical examination of the part removed, and were convinced that the mass cut away was a portion of the pancreas.

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[1] L'Union Médicale, n. s., t. xxi. pp. 408, 469. 1864.

[2] Op. cit., Part Second, Surgical Volume, p. 150.

In Thompson's case, the ball entered below the ribs on the right side and emerged on the left, and two days afterwards, while the patient was straining at stool, a hernia of the pancreas, as large as a hen's egg, occurred. The projecting mass was ligatured with silver wire, and cut away with scissors. The patient was convalescent in two months.

Some authors have asserted that, after an injury to the pancreas, there might be an effusion of colorless liquid, as a characteristic symptom of the lesion; and that after wounds of the thoracic duct, clear lymph, when digestion had not been going on, and a milky fluid after a meal, might escape from the external wound; but I am not aware that such an occurrence has ever been observed.

Penetrating wounds of the kidney have been described by almost all systematic writers, and a special dissertation on them was published by Gittler, at Leipzig, as far back as 1596. They present many differences, according as they affect the cortex only, or penetrate to the tubular and pelvic portions of the organ, and as they do or do not involve the peritoneum, or large bloodvessels of the kidney. From its anatomical position, wounds of the kidney, like sub-parietal ruptures, may be of two chief classes: (1) Those inflicted upon the posterior surface, and in which the peritoneum is not involved; (2) those affecting the front surface, and in which the peritoneal cavity is necessarily perforated, and very probably some of the other viscera are injured as well.

Symptoms.—The symptoms of a wound of the kidney will vary according to the situation and depth of the wound. If superficial, so that it involves the cortical structure only, blood and urine will escape at the external wound, or into the abdominal cavity, according to the situation of the injury. If the wound be deep, and the tubular structure or calyces are reached, blood will almost certainly be passed by the urethra, and clots are likely to accumulate in the bladder, though urine and blood may also escape into the surrounding parts. The injury is generally followed by great pain in the lumbar region, pain and spasmodic retraction of the testicle, nausea and vomiting, dysuria, muscular spasm or rigidity, and afterwards by nephritis, protracted suppuration, or more or less peritonitis. If the peritoneum is involved, and urine is extravasated into its cavity, fatal peritonitis must be expected. When the injury to the kidney is associated with wounds of the stomach, liver, spleen, or other important part, such as the intestines, diaphragm, or spine, a speedy death from shock, or shock and hemorrhage combined, is very probable. If the wound is outside the peritoneum, there may form, after several days, a dull swelling in the renal region, due to retro-peritoneal accumulation of urine, or of urine and blood. Diffused urinous infiltration into the cellular tissue of the loin is not a common occurrence. When hæmaturia occurs, it may come on at any time from a few minutes to a few days, though it usually sets in after a few hours; it may last for only a day or two, or extend over several days; it may be slight and merely sufficient to stain the urine, or it may be profuse and even fatal. Retention of urine, which has been known to last for four, five, or six days, and then to be followed by the passage of bloody urine and clots, has in some cases of punctured wound been a striking feature. In two gunshot cases, pieces of cloth from the soldiers' uniforms—in one instance accompanied by epithelial detritus, and in the other coated with phosphates—were passed by the urethra. Probably the most singular case on record, as illustrating nearly the whole series of symptoms of injuries of the kidney, is that recorded by Hennen:—[1]

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[1] System of Surgery, vol. ii. p. 147.

[2] Op. cit., 3d ed., p. 366.

[3] Transylvania Journ. of Med., vol i. p. 116. 1828.

> An officer was wounded by a musket-ball which entered close to the interval of the ninth and tenth ribs, about midway between the sternum and spine, and was cut out from near to the point of the transverse process of the lowermost dorsal vertebra, on the day after the receipt of the wound. Within an hour he voided a quantity of bloody urine. He was in extreme pain, which was aggravated by his being moved a distance of three leagues the same night. Soon the pain spread from his wound over his bowels, and delirium set in; he was then bled several times, and blisters were applied to his abdomen. Then followed intense pain in his right shoulder, and the wound in his back nearly mortified from his lying so long, but in seven weeks he was well enough to be sent to England. The journey excited fever, and peritonitis again set in; and a tumor formed in the site of the posterior wound, which was punctured at the end of a fortnight, and six ounces of pus having an urinous smell were discharged. The discharge continued for some time, and another abscess formed lower down, which was punctured in about three weeks, and a large quantity of pus of the same kind escaped. The abscess healed, and burst again and again; pain, emaciation, and frequent micturition, with actual lessening of the quantity of urine voided, together with the symptoms of renal colic, followed, and then at the expiration of seven months from the infliction of the wound, he passed *per urethram* something having the shape of a short, thick shrimp, which, upon examination proved to be a piece of cloth, covered with black grit. After this, he rapidly convalesced.

Diagnosis.—The situation and nature of the wound, and the presence of hæmaturia, or the escape of urine by the external wound, or some form of dysuria, accompanied by lumbar pains, are the most certain signs. Hæmaturia has been noted in the larger proportion of cases, and is so fairly constant a symptom that it ought to cause suspicion in cases in which there is neither dysuria, nor escape of urine by the wound, nor any evidence of urinary extravasation. If the hæmaturia is associated with, or followed by, traumatic peritonitis, the evidence becomes stronger. It must be borne in mind, however, that the kidney may be wounded without hæmaturia occurring, whilst hæmaturia may follow a blow without the kidney being wounded.

Prognosis.—Though dangerous, wounds of the kidney are by no means necessarily mortal. Hennen says:—

> The slightest reflection on the situation and structure of the kidney, and on its various sympathies, will at once show the desperate nature of wounds inflicted on it, even with all the caution of a curative intention. The instances that I have observed where

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[1] Op. cit., pp. 422 *et seq.*

recovery has been established, are very few indeed. If the patient has survived the first hemorrhage, the fever and peritoneal inflammation, with incessant hiccough and vomiting, and sympathy of the diaphragm and stomach, have generally cut him off; and if he has for a time escaped, excruciating pains, profuse suppuration from fistulous sores, hectic, and emaciation, have terminated his existence. Where the cure has been effected, there is reason to think that the ureter has been but slightly bruised, and the body of the kidney itself left untouched.

At the present day, however, we know from the success that has attended recent surgical operations upon the kidney, that this estimate of the danger of renal wounds is altogether too unfavorable. Haller, Bourienne, Borthwick,[1] Fallopius, Valleriola, Schenckius, La Motte, and other old writers, have given instances of recovery from incised and punctured wounds.

Sir A. Cooper mentions the case of a boy, whom he saw, who was struck in the back with a penknife; almost immediately he wished to make water, and passed a large quantity of blood. Hæmaturia continued for several days, but subsided by his remaining quiet in bed.

Mr. Ackerly,[2] of Liverpool, relates the case of a man, aged thirty, who was wounded in two places by the open blades of a pair of tailor's shears, the one entering the abdomen about two inches above the anterior superior spinous process of the ilium on the left side—from which wound about four inches of omentum protruded—the other entering near the spine, on the same side, just beneath the last rib. There were copious discharges of urine from the latter wound for two days. The omentum was cut away, and the bleeding vessels secured by ligatures. Recovery ensued in fourteen days.

Mr. J. Johnston[3] records a case of recovery, after wound of the kidney, in a man aged thirty-two. The wound was inflicted with a large table-knife, with a blade of 8½ inches, the whole of which penetrated the tissues. The peritoneal cavity was opened. Painful, spasmodic retraction of the testicle was the prominent symptom, and led the man to suppose that he had been stabbed in the groin. There was much hemorrhage from the wound, and within an hour after its infliction a pint of blood was passed by the urethra. Symptoms of peritonitis followed, and a peri-renal abscess had to be opened; quantities of urine escaped through the abscess-opening. The patient made a good recovery in about six weeks, and it is to be inferred, though it is not so stated, that a permanent urinary fistula was escaped.

In the Medical and Surgical History of the War of the Rebellion,[4] it is stated that out of a total of 78 cases of gunshot wound of the kidney recorded during the war, 26 ended in recovery; in 6 of the successful cases, the liver was also wounded. A case is given of quite miraculous recovery after considerable hemorrhage, six days of neglect of treatment, repeated journeys of many miles, a convalescence complicated by typhoid fever, and a renal abscess which discharged externally, followed by an urinary fistula which subsequently closed. This case teaches the important lesson, that a surgeon should never abandon as hopeless any case of injury, however unpromising it may at first sight appear. Twenty-one additional instances of recovery from gunshot wounds, and 14 of recovery after incised or punctured wounds of the kidney, are collected from various sources, and referred to by the editor, Dr. Otis. No instance of punctured or incised wound of the kidney was, however, known to have occurred in the War of the Rebellion. The great sources of danger from these wounds are (1) hemorrhage, if the great vessels of the organ are injured; (2) peritonitis, if the front surface of the organ, or any of the adjacent viscera, are penetrated. If the wound is inflicted upon the posterior surface, and neither peritoneum nor the great vessels of the hilus are wounded, recovery may be looked for. Indeed, it is not too much to say that whilst the kidney may recover from very considerable lesions, mere punctures or incisions of its substance are attended with a very small amount of risk. Death from other causes has rendered it possible to prove the complete cicatrization of wounds of the kidney. In one instance, recorded by Legouest,[1] a kidney, which had been penetrated from before backwards near its centre, had upon each face a depressed, solid, fibrous cicatrix, with fibrous rays branching from it. Urinary fistula of long duration is not a common result, even after gunshot wounds, for it is only reported in one out of the twenty-six recoveries during the War of the Rebellion. The duration of life in the fatal cases has varied from a day or two, to eight or nine months, or more—the early deaths having been due to shock or hemorrhage, the later ones to protracted suppuration. In many cases the fatal result has been due to peritonitis, nephritis, and cystitis.

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[1] Hennen (op. cit., p. 425) refers to the cases of these three observers.

[2] Observations on Wounds of the Abdomen. Lond. Med. Gaz., vol. xx. p. 549. 1837.

[3] Brit. Med. Jour., April 4, 1857, p. 275.

[4] Op. cit., Part Second, Surgical Volume.

Treatment.—"The remedies consist of venesection, mild purgatives, such as manna, oil, etc., frequent emollient enemas, the warm bath generally, and local fomentations, so as to excite diaphoresis and to moderate urinary secretion; with a diet of the mildest kind, but much restricted in fluids, the indulgence in which, even in small quantities, should be avoided. Stimulants under any form, particularly those which can at all influence the urinary organs, and blisters and diuretics, are decidedly hurtful. The dressing should be extremely light, so as to admit of free percolation of the urine; the neighboring parts should be varnished over with some unctuous substance to prevent excoriation, and the bedding should be protected by oil-skin. By these means a few cases that have come to my knowledge have terminated favorably." So wrote Hennen, in 1818, and with the exception of venesection and frequent emollient enemas, these directions cannot be improved upon. The experience of recent times has not been favorable to venesection in abdominal wounds, and in the case of injuries to such organs as the spleen, liver, and kidney, the shock and hemorrhage resulting from the accident often render it unwarrantable. Mild purgatives and emollient enemas are indicated if the bowels, especially the large bowel, are loaded; but after these have been once freed of their contents, the quieter they are kept the better. It is, however, very undesirable that a mass of hardened feces should rest in the colon, and act as a source of irritation to the neighboring and injured kidney. The treatment of the wound cannot be too simple. It should be left open for drainage, unless it be a very large, incised wound, when one or more deep sutures may be introduced to bring a part of the edges together. Unless its course be very oblique, it will rarely be necessary to enlarge the wound for the purpose of preventing infiltration of urine, and in a case of gunshot wound, the tissues are at first protected by the eschar of the bullet track, and subsequently by a limiting wall of inflammatory lymph. If at a later period phlegmonous inflammation or extravasation occurs, free incisions are most important; and if a circumscribed collection of urine or blood is formed, repeated aspirations may bring about a cure. The importance of removing clots of blood from the bladder has been mentioned in describing the treatment of ruptured kidney, and it cannot be too fully emphasized. The catheter and warm-water injections should be first tried, but if these are insufficient, either owing to the quantity of coagula or to their continual formation, cystotomy should be performed without delay. It matters but little whether this be done by median or by lateral incision, as long as there is a free exit for the escape of the clots. It is impossible to read the account of Hennen's celebrated case, or to have witnessed the sufferings of Mr. Hilton's patient, to whom I have before referred, without feeling convinced that each of them would have been saved a world of pain had cystotomy been performed. In Hennen's case, moreover, the operation would doubtless have led to the early detection and removal of the foreign body in the bladder, to the expulsion of which, along the urethra, the agony of the latter period of the case was due.

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[1] Chirurgie d'Armée, 2e éd., p. 403.

Hemorrhage should be checked by the internal administration of large and quickly repeated doses of ergot, and by the local application of ice and well-applied pressure upon the loin; care must meanwhile be taken to secure good drainage of the wound. If life be threatened by hemorrhage or suppuration, the kidney ought to be removed by lumbar nephrectomy. Protrusion of the injured organ at the time of the accident, or subsequently from coughing, may also render its removal expedient.

Wounds of the Ureter.—With the exception of the gunshot wound of the ureter in the person of the Archbishop of Paris,[1] in 1848, and the doubtful case recorded by Hennen,[2] there does not appear to be any published instance of wound of the ureter alone. None occurred in the war of the Rebellion; and when the calibre of the ureter and its secure and protected position are considered, this is not surprising. In all the recorded cases of injured ureter, whether penetrating or subcutaneous wounds have been inflicted, and whether the kidney has been associated in the injury or not, it has always been the pelvic dilatation, that is the ureter close to the kidney, which has suffered. Hence the diagnosis, symptoms, sequelæ, and treatment of injured ureter, as far as our knowledge extends, in no way differ from those of rupture or wound of the kidney, nor is there any *a priori* reason for supposing that they should. The following are the notes of the case of the Archbishop referred to:—

During the revolution of 1848 (June 29), the Archbishop of Paris was wounded by a ball at the upper part of the lumbar region, on the right of and close to the spine. The ball was lodged in the body. He had intense suffering, great depression, paralysis of the limb, but no anæsthesia with it. After recovering from slight collapse, reaction set in, accompanied by continued and acute pain, more especially in the left leg and down the course of the sciatic nerve. Nausea and vomiting supervened; the countenance became pale and anxious; the abdomen was flaccid and not at all painful. The wound was enlarged, and unsuccessful attempts were made to extract the ball. There was no urine in the bladder, but a quantity escaped by the wound. Death ensued in eighteen hours. On examination, the ball was found to have fractured the transverse process of the third lumbar vertebra, to have then changed its direction and traversed the body of the same vertebra, and to have divided the cauda equina just below its origin. After leaving the vertebra the ball had changed its direction again, had passed up toward the left kidney, had divided the ureter near the pelvis, and, finally, had lodged in the psoas muscle. All the cellulo-fatty tissue about the left kidney was infiltrated with urine, and there was slight ecchymosis in the substance of the organ itself.

Mr. Holmes,[3] a few years since, recorded a case of great interest, which, at the time, he considered to prove the possibility of a direct and uncomplicated wound of the ureter through the posterior parietes of the abdomen. A boy, aged 13 years, was stabbed by a clasp-knife, which entered the back just on the right of the middle line, and about on the level of the posterior superior spine of the ilium. The wound took a direction upwards and outwards, and through it there flowed for two weeks a quantity of a colorless, odorless, neutral or slightly alkaline fluid, of sp. gr. 1008. After this time the flow ceased altogether. The author concluded that this fluid must be either urine from a punctured ureter, or cerebro-spinal fluid, and he strongly inclined to the view that it was not cerebro-spinal fluid. It is quite certain, however, from the composition of the fluid, that it was not ordinary urine, and was much more nearly like cerebro-spinal fluid; and as Mr. Holmes has, in a subsequent communication,[1] come to the conclusion that this case was really one of wound of the theca vertebralis, and not of the ureter, I need do no more than say that he has at least shown, by experiment on the dead subject, that it is possible to wound either the ureter or the theca vertebralis by a stab in the back, at the position of the wound in this boy.

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[1] Gazette des hôpitaux, 1848.

[2] Op. cit., 3d ed., p. 430. Case LXXII.

[3] Med.-Chir. Trans., vol. lx.

There is another way in which the ureter not only may be, but has been, wounded, and that is during the removal of ovarian and other abdominal tumors, as well as in the removal of the uterus. In the complete removal of the uterus the ureter stands in very real danger of being divided, especially if the operation is being done for cancer of the cervix. It happened once to myself to divide the ureter on one side whilst removing the uterus for malignant disease; the cervix was so enlarged and infiltrated with cancer that it greatly exceeded the fundus in circumference, and it was quite impossible to excise the tissues clear of the disease without cutting out about half an inch of the right ureter, which was incorporated with the growth on the side of the cervix. The renal end of the divided ureter was turned into the vagina and retained there by a suture. Should the ureter be accidentally torn or cut across whilst removing an abdominal tumor, the renal end must be brought out through an opening made for this purpose in the loin, and fixed by a suture to the edge of the wound.

It was after an accident of this sort that Simon, of Heidelberg, for the first time successfully removed a kidney in order to rid his patient of a urinary fistula.

Wounds of the Supra-renal Capsule.—One case of gunshot wound of the left supra-renal capsule is described in the Medical and Surgical History of the American War of the Rebellion. The shot had traversed the left lung and the diaphragm, and had lodged in the supra-renal capsule, where it was found imbedded after death. The man lived four weeks, and died of pyæmia. He suffered "no hæmoptysis, not much oppression of breathing, scarcely any hemorrhage, no disorder of the uropoietic functions, and comparatively little shock at the outset—the reverse of what would be anticipated from Kölliker's observation, that the supra-renal capsule is more highly supplied with nerves than any other glandular structure, and that the nervous branches are derived from the sympathetic, pneumogastric, and phrenic nerves."

There are no clinical records of any case of uncomplicated wound of the supra-renal capsule; and we have no observations to show how far injury to these bodies would produce the symptoms of Addison's disease, or lead to the retention in the blood of some poisonous substance which certain physiologists have imagined that it may be the function of these organs to remove.

PENETRATING WOUNDS INVOLVING THE LYMPHATICS AND BLOODVESSELS.—*Wounds of the thoracic duct* are very uncommon, and, with one or two exceptions, probably unknown. Quincke's case was verified by a post-mortem examination; and Monro's was also probably a genuine case of wounded thoracic duct. The discharge of a milk-like fluid from a wound in the loin, especially if the wound were of the nature of a stab, or gunshot, would, as Benjamin Bell remarked, suggest this injury. But the secure position of the thoracic duct, not only in its short course below, but in its longer course above the diaphragm, makes an uncomplicated wound of this tube extremely improbable. Lying as it does between the aorta and vena cava, it is almost impossible to conceive of its being punctured or divided without one or both of its companion vessels being injured also; and in such a case death would occur before the symptoms due to the injury of the lymph-duct would have time to develop themselves.

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[1] Med.-Chir. Trans., vol. lxv.

Wounds of the smaller lymph-vessels must of a certainty occur whenever the mesentery, viscera, or parietes even, are wounded; but such wounds heal quickly, as do those of the small arteries and veins.

John Bell's perusal of his namesake, Benjamin's, very harmless suggestions as to the probable results of a wound of the "receptaculum chyli," inclined him to write some very uncharitable things,[1] which, with the knowledge of those who lived after him, he would have left unsaid, as he would have recognized that Benjamin Bell was sometimes wiser than himself.

Penetrating Wounds of the Bloodvessels of the Abdomen.—The bleeding which results from penetrating wounds proceeds from either (1) the vessels of the parietes; (2) the viscera, omentum, or mesenteries; or (3) the large bloodvessels, or their branches to the viscera or parietes. Wounds of the great vessels are, as a rule, fatal, the patients perishing before help can be procured. The bleeding from such vessels as the epigastric, intercostal, lumbar, or circumflex iliac arteries, is by no means trivial or unimportant, and may be fatal if trifled with or mismanaged.

The viscera, omenta, and mesenteries are so well supplied with vessels, that they can hardly be wounded without their vessels suffering. When any of the smaller vessels within the abdominal cavity are wounded, the pressure exerted by the abdominal parietes, and through them of the contained viscera, is often sufficient to control or check the hemorrhage. This pressure is, as remarked by Petit, a veritable compression which nature employs to suspend or moderate the effusion. The rapidity and amount of hemorrhage depend, therefore, upon the size of the vessel wounded, and the degree of resistance to effusion exerted by the contiguous structures. If the wounded vessel be large, the force with which the blood tends to escape will probably be greater than the resistance; if the force and the resistance nearly balance each other, it may happen that a slight extravasation will increase the resistance sufficiently to completely prevent further hemorrhage.

Symptoms.—When wounds of large vessels prove quickly fatal, the blood descends into the pelvis, the belly swells, and the patient grows pale and pulseless, anxious in aspect, restless, and cold, then becomes suffused with clammy cold sweats, and, after several convulsive movements, dies.

When the wounded vessel is under a certain size, the hemorrhage is slower, and some time elapses before the extravasation is considerable. After a time, a soft, dull fluctuating tumor may be felt in the lower part of the abdomen; the pressure made by the effused blood on the urinary bladder excites distressing efforts to micturate, and that on the large bowel leads to constipation and tenesmus. At a later period, the peritoneum becomes, perhaps, inflamed, the pulse grows feeble, and the alarming symptoms above described usher in death; or peritonitis may be escaped, and by slow degrees, if the hemorrhage ceases, the effused blood is absorbed and convalescence is established.

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[1] Op. cit., 3d ed., p. 366, *et seq.*

Dr. Colles, in his lectures, relates the case of a carpenter who stumbled and fell upon the edge of a chisel, which he was carrying in his breeches-pocket; the chisel penetrated the peritoneal cavity, and in doing so, wounded the epigastric artery. The man, pale, exhausted, cold, and pulseless—in fact, collapsed and faint—died in the course of a few hours. The cavity of the peritoneum was found distended with blood.

Ravaton[1] relates the case of a soldier, wounded by a sword which entered the abdomen, and, passing between the viscera without injuring them, opened the vena cava. Blood at once filled the peritoneal cavity, and death was immediate. He mentions[2] another and similar case, in which both aorta and vena cava were opened without any other internal injury.

Hildanus records the case of a young man who was stabbed between the false ribs and the umbilicus, and who died instantly from internal hemorrhage from a wound of the unobliterated umbilical vein.

Sir E. Pakenham was killed on the spot at New Orleans, by hemorrhage from a wound in which the common iliac artery was divided; and Guthrie, on whose authority this statement is made, records a very similar accident[3] to a soldier who was wounded by a musket-ball, which entered at the groin and made its exit at the back. When seen by a surgeon for the first time, on the fifth day after the accident, the foot and leg were mortified. The countenance had a cadaverous appearance; the pulse was small and weak; there were some nausea and retching, and the patient died eleven days after the injury. On post-mortem examination, the ball was found to have completely divided the external iliac artery; about a pint of coagulated blood, mixed with some excessively fetid pus, was collected in the pelvis; the ends of the artery had receded considerably from each other, and a coagulum had formed in each. There were signs of peritoneal inflammation, the intestines had not been wounded, and the ball in passing out had splintered the upper edge of the back of the ilium.

In South's Chelius[4] is to be found the record of a case in which an iron spike traversed the abdomen of a man, aged fifty-two; tore the right common iliac vein; and deeply indented the third lumbar vertebra without injuring the viscera. The patient had vomiting, pain, and tenderness, and died on the third day. There were no marks of peritonitis, but the omentum was adherent to the external wound.

During the War of the Rebellion,[5] an elongated ball entered one inch to the right of a soldier's umbilicus, passed inward through the intestine, and out close to the spine, dividing the lowest intercostal artery. The man died the same day from hemorrhage. On the same page of the History is the report of another fatal case, in which death occurred from repeated hemorrhages from the musculo-phrenic and superior epigastric arteries; the ball had entered two inches above and to the left of the ensiform cartilage, and passed out in the left hypochondrium, opposite to the spleen. The splenic flexure of the colon was gangrenous, and there was a large abscess-sac between the points of entrance and exit. An interesting case is also reported (p. 175), in which both epigastric arteries were completely divided by a ball which entered at one inguinal region and emerged at the other, cutting through the entire abdominal wall from one side to the other about half an inch above the pubis, and leaving a gaping wound about eight inches long. The man was convalescent on the twenty-sixth day. C. J. M. Langenbeck relates an instance of fatal hemorrhage from a stab in the belly, in which the bleeding was found to proceed from the ascending branch of the left colic artery.

Treatment.—It is important that there should be fixed rules in dealing with these cases of penetrating wound attended with hemorrhage from wounded vessels. The first is, that reliance must not be placed upon any astringents, or compression by pads and bandages. In hemorrhage from a wounded liver or kidney, the internal administration of ergot, and the local application of iced-compresses, are often of service, and are the only means available; but when an artery or vein—whether of the parietes, of the omentum, or of one of the mesenteries—is the source of bleeding, there is the utmost danger in temporizing with such remedies. The second rule, therefore, should be to enlarge the wound when necessary, and to search for the source of hemorrhage. Ligatures or torsion should then be applied to the vessel at the wounded part, blood should be carefully removed from the peritoneum, and the external wound should be closed in the usual manner. Catgut ligatures are generally used for the adhesions and vessels divided in ovariotomy, and experience has shown that there is no danger in putting on a large number of them, and leaving them, cut short, in the cavity of the peritoneum. Care should be taken to cleanse the peritoneum from fluid blood and clots.

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[1] Chirurgie d'Armée, etc., Obs. CCXLIII.

[2] Ibid., Obs. CCXLIV.

[3] On Wounds and Injuries of the Abdomen, etc., p. 62, Case XCIII.

[4] System of Surgery, vol. i. p. 458.

[5] Medical and Surgical History, etc., Part II., Surg. Vol., p. 176.

The pernicious doctrine of Jourdan, that surgery is powerless in lesions of the bloodvessels of the abdomen, ought not to paralyze the hand of the surgeon, who should in cases of free hemorrhage feel himself called on to expose and, if possible, secure the wounded vessel, whether in the walls of or within the abdomen, and should decline to rely on general measures, such as tents, compresses, and styptics. It is quite possible, however, that in some cases—such as that above referred to, in which the musculo-phrenic and superior epigastric arteries were injured—it might be impossible to ligate the vessel at the seat of the wound; but in that event the same rule should be followed as in injuries to vessels of the limbs—viz., the trunk should be tied between the wound and the heart. Thus, in the case of the musculo-phrenic, the internal mammary artery could be ligatured in the second or third intercostal space; for though the anastomosing currents are free and would soon be established, still a good chance would be afforded for the closure of the wound by clot. Even large trunks, when divided by shot, are sometimes completely closed as if by torsion, but in punctured or incised wounds this is seldom, if ever, the case.

On Wounds of the Abdomen made by the Surgeon.—It would be out of the province of this article to describe in detail all the many wounds which the surgeon from time to time inflicts upon the abdomen in the useful exercise of his art, but it may be well to enumerate the chief of them, some of which will find place in subsequent portions of this article, and others in the articles on hernia, intestinal obstruction, and injuries and diseases of the pelvic organs.

1. *Opening the abdomen* for the relief of various sources of internal strangulation, including internal herniæ, bands, twists, obturator and ischiatic herniæ; for the excision of portions of the stomach or bowel when strictured, or the seat of malignant disease; or for the removal of other viscera, such as the kidney, spleen, uterine appendages, etc.
2. *Opening the stomach* for the removal of foreign bodies, and for the prevention of starvation in strictures of the œsophagus.
3. *Opening the small intestines* has been proposed for the removal of foreign bodies, and in cases of intussusception. It rarely, however, occurs that a foreign body becomes impacted in the bowel so as to require removal; and in intussusception, either the invaginated bowel can be pulled out, or the affected part, if sloughy, will require excision. The small intestine is sometimes opened for the relief of intestinal obstruction which is seated above the cæcum, and the cause of which cannot be made out. In these cases the opening should be made for the sake of giving relief to the patient, on the same grounds that the bladder is punctured in cases of impassable stricture.

I have opened the ileum a short distance above the cæcum, through a slightly-curved incision, one inch above the spine of the ilium and outer part of Poupart's ligament, on the right side; and immense relief from the anguish of distension followed the evacuation of an enormous quantity of fluid fecal matter and gas.

4. *Opening the large intestine* is performed for the relief of intestinal obstruction. Either the cæcum, the ascending or descending colon, or the sigmoid flexure, may be the seat of the operation. In the ordinary operation of colotomy, whether on the right or left side, the peritoneum should be avoided. In this operation it is uncertain, in any given case, what spot on the ascending or descending colon will be reached through the incision. In left colotomy, any part from just below the splenic flexure to the sigmoid flexure, may present itself at the wound.

In some cases, such as those of imperforate or defective rectum, the sigmoid flexure should be opened in the left iliac fossa. This is the operation known by the name of Littre, having been first proposed by him in 1720, though it was first practised by M. Dubois in 1783. M. Huguier has recommended that the opening should be made in the right groin instead, because of the occasional deviation, in cases of deficiency of the rectum, of the sigmoid flexure to the right side, instead of its ending on the left. The cæcum has been opened in the right iliac region by an oblique incision above Poupart's ligament, by M. Pillore; and in a case related by Mr. Avery to the London Pathological Society, the cæcum was opened by an incision six inches long in the right groin.[1]

5. *Opening the uterus* may be performed, first, by opening the peritoneal cavity, and secondly, by avoiding the peritoneum.

Opening the uterus through the peritoneum is generally done (1) by a longitudinal incision through the median line. I have twice had occasion to perform this operation, and once[2] with the result of saving both mother and child; in the other case,[3] craniotomy had previously been employed, but without delivery *per vias naturales* having been made possible: the woman was in a most exhausted condition therefrom, and survived the operation only seventy-two hours.

(2) The lateral incision was anciently adopted, the left side being preferred, and the line of selection being along the outer edge of the rectus abdominis, for about six inches. This operation fell into disuse on account of the danger of wounding the epigastric artery, and the great tendency to retraction of the muscles. This is a point worth bearing in mind in the selection of the line of operation in nephrectomy.

(3) The transverse incision, recommended by Lauverjat, was made five inches long, between the edge of the rectus and the spinal column, and more or less high according to the elevation of the womb.

Opening the uterus without injuring the peritoneum has been performed in three different ways. (1) Dr. Physick proposed a transverse incision immediately above the pubis; the peritoneum was to be detached, as it easily can be, from the bladder and neck of the womb, and the womb was then to be opened without dividing the peritoneum. (2) M. Ritgen recommended that the neck of the uterus should be reached and opened by dividing the abdominal muscles along their attachment to the crest of the ilium, and then detaching the peritoneum. (3) M. Baudelocque commenced his incision near the spine of the pubis, and prolonged it, parallel to Poupart's ligament, beyond the anterior superior spine of the ilium on the side opposite to that on which the womb was most inclined. He did not divide the epigastric artery, but raised the peritoneum from the iliac fossa until he exposed the upper part of the vagina, which he opened, and then with his finger introduced into the os uteri drew the womb toward the wound in the parietes, making pressure meanwhile upon the fundus; when he had succeeded, he left the labor to be effected by uterine contractions. He preferred the left side for the operation.

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[1] Trans. Path. Soc. Lond., vol. ii. p. 222, and vol. iv. p. 156.

[2] Trans. Obstet. Soc. Lond., 1883.

[3] Lancet, 1879.

6. *Opening the bladder above the pubis.*—This is done under exceptional circumstances for the removal of stone, but other less dangerous, and therefore preferable, methods of extraction have caused this to be rarely practised at the present day. It is called the high operation for stone, or hypogastric lithotomy, and is said to have been first performed in 1475, in Paris, by Colot, as an experiment on a criminal, by permission of Louis the Eleventh; the patient recovered in a fortnight. In Amussat's proceeding, as described by Malgaigne, the bladder is first distended with water; but in the method of Baudens, no injection into the bladder is previously made. Both operations are arranged so as not to wound the peritoneum, but this has not always been successfully carried out. Puncture of the bladder above the pubis, for the relief of urinary retention in enlarged prostate or impassable stricture, is still occasionally performed. The peritoneum is not wounded. The puncture may be made with an ordinary trocar and canula in the median line, about one or one and a half inches above the symphysis, either after, or without, making a previous incision through the skin and fat. Desault advises that the puncture should be made a little above the pubis, so as to avoid injuring the peritoneum. Or instead of an ordinary trocar and canula, the perforated needle of the aspirator may be used with advantage. I have on several occasions resorted to this latter measure for the temporary relief of retention.

7. *The operations for removing ovarian cysts and fibro-myomata of the uterus*, with Porro's, Freund's, Battey's, and Müller's operations, are all described in their appropriate chapters. There are no major operations in surgery which are more successful than ovariotomy, and none which exemplify more fully how much interference the peritoneal cavity tolerates, provided that every care be used to avoid sources of danger in the manipulations, and in the mode of cleansing and dressing the parts.

8. *The various operations on the kidney of nephrotomy, nephro-lithotomy, and nephrectomy* will be described in detail in a subsequent portion of this article: suffice it here to say that all may be, and that the two first always are, performed without opening the peritoneal cavity. Nephrectomy, if not performed by the lumbar incision, entails an incision of the peritoneum in two places.

9. *Cholecystotomy* appears to have met with a large measure of success; and with this operation may be mentioned those incisions and punctures for the treatment of hydatid and other cysts, and abscesses, of the various organs and structures of the abdomen.

10. *Operations for the ligature* of the iliac vessels, the abdominal aorta, the epigastric and other arteries, have been considered in a previous volume.[1]

11. *The various operations for hernia*, its radical cure, and the relief of strangulation, will be dealt with in the article devoted to that subject.

12. *Paracentesis Abdominis.*—This is in fact a punctured wound of the abdomen, its object being the withdrawal of fluid from the peritoneal cavity or from an ovarian cyst. A small incision, about three-fourths of an inch long, should be made through the skin and fat over the linea alba, slightly above the mid-point between the umbilicus and pubes. A simple, round canula, with a trocar, the point of which should be very sharp and in the shape of a three-sided pyramid, should then be thrust through the linea alba into the abdomen, and when the instrument has well entered the cavity, the trocar should be withdrawn whilst the canula is pushed in further. The patient

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[1] See Vol. III. pp. 311 *et seq.*, *supra*.

should be lying near the edge of the bed, on his back, with the shoulders raised; or if there be pain or distress in moving, the operation may be performed whilst the patient lies upon his side. I have often tapped in this way without any inconvenience to myself, and without causing discomfort by movement to the patient. The canula should be about three inches long and one-quarter of an inch in diameter, and for convenience it should have an India-rubber tube fixed to its side, or readily adaptable to its end after the withdrawal of the trocar, to avoid wetting the bed, and for the purpose of conveying the fluid to a pail or basin on the floor by the side of the bed. The old plan of performing the operation whilst the patient was sitting in a chair, is not to be followed; though it is well still to employ what was absolutely needful to prevent syncope when this method was in vogue, namely, a broad flannel roller, or round-towel, applied around the belly, the ends being crossed behind and held by two assistants, who stand one on each side of the patient, and who by gently tightening the bandage maintain support on the organs and large vessels of the abdomen, whilst the fluid flows away. A hole should be cut in the centre of the bandage, so that the spot at which the puncture is to be made should be left uncovered. When all the fluid which can easily be drawn off has escaped, the canula should be withdrawn, and the wound covered with a small pad of lint secured by a broad strip of plaster; and a flannel roller should then be bound firmly around the abdomen.

Though this operation is commonly esteemed one of the simplest in surgery, there are, nevertheless, certain precautions requisite, for it is not without its dangers. The *first* precaution is to make sure that the bladder is empty; this should be done by the introduction of a catheter, or by getting the patient to pass water if the catheter is objected to, and not by trusting to percussion, as has been absurdly suggested. In some cases of ascites in which tapping is most needed, the whole of the front of the belly is dull on percussion, and in ovarian dropsy this is always the case. The *second* precaution, is not to reintroduce the trocar if the flow ceases before all the fluid has run off, lest it wound the intestine. Some blunt-ended probe, or a catheter, may be passed through the canula so as to keep aside the intestine or omentum, which by floating up against the end of the tube may effectually obstruct the flow. *Thirdly*, the surgeon should ascertain before making the puncture, and whilst the patient is in the position to be occupied during the operation, that the part is dull on percussion. This is especially needful in secondary tappings, as it sometimes happens that a coil of intestine becomes adherent to the seat of previous puncture; we should, therefore, be on our guard in operating through the cicatrix of an old puncture, though the practice is sanctioned by many.[1] *Fourthly*, it is always well before surrounding the abdomen with the binder which is to be used during the operation, to make a mark with iodine, caustic, or ink, at the spot at which the puncture is to be made. With the abdominal walls distended, perhaps unequally, it is very easy to mistake the median line, more especially with the patient on his side, and only a small area of the surface exposed through the hole in the bandage. By not taking this precaution the epigastric artery has been wounded, and fatal hemorrhage has occurred from it. Dr. James Carmichael Smyth,[2] in 1790, enumerated ten cases in which death had been caused by wound of the epigastric artery or its branches, whilst performing paracentesis. South, in his notes to Chelius, has collected some such cases; two more (one fatal) in which the source of the bleeding is not stated, were witnessed by Sir Thomas Watson;[1] and Dr. F. H. Hamilton has recorded one in which the accident happened in his own hands, but in which the patient fortunately recovered.[2] Should such a catastrophe occur, and the consequent hemorrhage be at all free, as in all probability it would, the wound should be sufficiently enlarged to allow of the wounded vessel being secured, and no dependence should be placed on pressure or styptics. *Fifthly*, paracentesis should not be resorted to either in ascites or in ovarian dropsy, until it is absolutely indispensable. *Sixthly*, the surgeon should be careful to ascertain, by personal examination, that the supposed ascites is neither a pregnant uterus nor a distended bladder. This caution cannot be thought superfluous, for it is stated, on the authority of Sir Everard Home, that no less a surgeon than John Hunter once actually tapped a distended bladder in the belief that the disorder was ascites, and a well known surgeon told me that he himself had once been summoned to meet in consultation two physicians and the family attendant, for the purpose of performing paracentesis abdominis, and that the operation would have been done had my friend not discovered that the young lady's malady was pregnancy. In cases of encysted dropsy, or of dropsy associated with solid tumors or pregnancy, it will be requisite to tap elsewhere than in the median line—or in the median line at a much higher spot than that usually selected.

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[1] A case illustrating the danger of wounding intestine which has become adherent to the parietes after a prior tapping, is recorded in the Lancet for 1827, vol. ix. p. 637. In the Trans. Path. Soc. Lond., vol. ii. p. 203, is the record of a case in which the jejunum was wounded by a puncture made about an inch below the umbilicus; a fistula discharging bile existed for five weeks afterwards, and then closed.

[2] Medical Communications, vol. ii. p. 482.

The linea semilunaris used to be the old seat of operation, but was abandoned on account of the risk of wounding the epigastric artery. In France, it was the custom to puncture at the mid-point of a line extending from the anterior superior spine of the ilium to the umbilicus.

I have in some few cases known oozing of fluid to follow paracentesis abdominis, and great advantage to accrue from the leakage. It certainly saves an early repetition of the operation. My learned colleague, Dr. Henry Thompson,[3] attributes the cure of one of his cases of ascites in a great measure to the continued outflow of serum from the wound in the abdomen, and he has several times, when I have been called upon to do the operation in his ward, asked of me the question: "Is there any danger in prolonged percolation of fluid? Can it induce peritonitis by propagation of morbid action from the wound, and if not, how can it be artificially maintained?"

Acupuncture of the dropsical belly was occasionally performed years ago, where ordinary tapping was thought unsafe. It was many times performed by Dr. Robert Lee, and received the sanction of Sir Thomas Watson.[4] As much as ten gallons of liquid have escaped from the little puncture made by the passage of a grooved needle. Two days and nights the fluid has continued to flow. In one instance, though only four ounces of liquid followed the puncture, that which was left behind gradually disappeared. The introduction by Dr. Southey of his capillary drainage-tubes has furnished us with the means of starting and maintaining with safety this small continuous outflow of ascitic fluid. The tubes have answered admirably in the cases in which I have employed them.

SUTURE OF THE INTESTINES.

At the present time, when the advances made in abdominal surgery are so rapid and so great, and more especially now that the surgical mind is bent upon the subject of enterorraphy, and particularly active as to the methods best adapted for the removal of portions of the intestines and stomach, a new Encyclopædia of Surgery would be imperfect if it did not contain a historical sketch of the use of sutures in closing wounds of the bowels. Whilst I was engaged in acquiring information on this subject for the present article, I turned, in the course of my researches, to the Fothergillian prize essay of Mr. Alfred Poland, one of my former teachers at Guy's Hospital. Here I found, besides other valuable information, so complete and methodical a summary of the several methods which have been adopted from time to time, that I make no apology for giving Mr. Poland's account in full—more especially as this admirable manuscript essay is not within the reach of foreign or provincial English readers.

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[1] Lectures on the Practice of Physic, 4th ed., vol. ii. p. 418.

[2] Princ. and Pract. of Surgery, p. 765. 1872.

[3] Clinical Lectures and Commentaries, Case XI. p. 193.

[4] Op. cit., 4th ed., vol. ii. p. 418.

If, in addition to this account, the reader will consult the interesting and very full historical survey of enterorraphy in Dr. Otis's Medical and Surgical History of the War of the Rebellion, he will learn nearly, if not quite, all that has been done in this field of surgery, a field which has been actively worked in since the thirteenth century. Mr. Poland writes:—

In enumerating the different kinds of suture, we shall advert to them in the order in which they have been recommended, according to the extent of the wound of the bowel. The following table will sufficiently indicate the plan adopted:—

1. Partial wounds.	1. Interrupted, noose, or loop suture.	a. Method of Palfyn.
		b. " " Ledran.
		c. " " Reybard.
		d. " " Jobert.
		e. Common interrupted suture.
	2. Uninterrupted, glover's, or continued suture.	a. The ordinary method of glover's suture.
		b. Method of Reybard.
		c. " " Bertrandi, or suture *à points passés*.
		d. Spiral suture.
2. Complete, or nearly through the whole tube.	1. Upon a foreign body.	a. Method *des quatres maitres*.
		b. " of Sabatier.
		c. " " Duverger.
		d. " " Jobert.
		e. Other varieties.
	2. With invagination.	a. Method of Ramdohr, and varieties.
		b. " " Reybard.
	3. With contact of serous surfaces.	a. Method of Jobert.
		b. " " Denans.
		c. " " Lembert.
		d. " " Gély.
		e. Other varieties and modifications.

Partial wounds, whether they are longitudinal or transverse, if exceedingly small, may be treated by the method adopted by Sir A. Cooper and others. The operator includes the aperture of the intestine in the forceps, and applies a silk ligature, to be carried beneath the point of the instrument, firmly tied upon the gut, and the ends cut off close to the intestine. This proceeding, however, will not apply to wounds larger than a simple puncture; hence, should a suture be determined upon, we must adopt one of two proceedings, viz., the interrupted or the uninterrupted suture.

I. THE INTERRUPTED, NOOSE, OR LOOP SUTURE.—a. *Method of Palfyn* (1710—1726). Palfyn passed a loop of thread through the middle of the wound of the intestine, fixing the threads to the integument by plaster, and thus approximated the bowel to the external wound. He brought the threads out through the wound, and did not stitch the gut to the integument, as stated by some authors.[1]

b. *Method of Ledran* (1742).—Ledran took as many threads as he wished to make points of suture, and threaded each in an ordinary sewing-needle. Having brought the edges of the wound together, he passed the needles directly through without any obliquity, about one-quarter of an inch apart. When all were put through, he removed the needles and tied together the threads of each side separately, forming two bundles, which were then twisted together into one. Thus the wounded portion of the bowel was puckered, and the points of suture approximated: it was considered that these puckers would prevent the edges of the wound from being separated, and would cause their mutual reunion without adhesion to any other part. The ends were fixed externally.

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[1] Lapeyronie's method slightly differed from Palfyn's, in that he inserted the thread through the mesenteric attachment, and stitched the bowel to the margin of the external wound. (Mém. de l'Acad. de Chir., t. i. p. 337. 1743.) Larrey successfully employed this method in a case of complete division of the ileum by a musket-ball. (Mém. de Chir. Mil. et Camp., t. ii. p. 160.)

c. *Method of Reybard* (1827).—Reybard used a thin and polished, oval plate of deal, one and a half inches long by three-quarters of an inch wide. He suspended it by loops of thread, which traversed its middle, the threads being about two lines apart, and each end of the several threads being then inserted into a needle. This plate was passed into the bowel, and so placed that its greatest diameter corresponded to that of the wound, and was maintained there by passing the needles through the intestine about one-quarter of an inch from the edges. The two ends of each thread were then withdrawn and threaded together in a curved needle, which was carried through the integuments from within outward, about one-quarter of an inch from the external wound. The threads were then held by an assistant, and the bowel reduced, taking care to have sufficient traction to retain the wound of the intestine applied against the abdominal parietes. The threads were then laid over a roll of linen and placed parallel to the internal lip of the wound. About two days after, the threads were cut and the plate of wood passed by stool.

d. *Method of Jobert.*—The edges of the wound are turned in with a needle, and threads passed transversely through the borders, keeping the serous membranes in contact, and avoiding protrusion of the mucous coat in the intervals; then the threads are collected in one bundle and brought outside, as in Ledran's method, or as many points made of the interrupted suture as there are threads.

e. *Common interrupted suture*, without any modification, as many points of suture being made as are thought requisite. Dr. Gross made fourteen experiments, one only of which was fatal after complete division of the tube. In some, the stitches were four or five lines apart. In ten, the sutures were cut short, and in all they either passed or were in progress of passing into the cavity of the bowel. He remarks on the great rapidity with which single stitches are detached, when compared with the glover's suture. The latest period at which they were found adherent was the seventeenth day, and in two experiments they were detached on the seventh and eleventh days respectively. He quotes the following cases on record, where the suture was used, five successful and two fatal. The two fatal cases are quoted from Sir A. Cooper on Hernia. Three successful cases occurred in America; one is referred to in the Edin. Med. and Surg. Journ., vol. xii. p. 27; and the fifth case is detailed in the Med.-Chir. Review, vol. xx. p. 182. However, there are several other remarkable instances—one in the Med.-Chir. Review, vol. vi. p. 557, a case of recovery under the care of Dr. Washburn; and another detailed by Dr. Fuchsius, in the Journ. der pract. Heilk., Februar, 1825, where he diagnosed intussusception, cut into the abdomen, drew out the invaginated bowel, cut into the gut, disengaged the invaginated portion, which was two feet in length, and united the wound by sutures, the patient recovering in fourteen days. Dieffenbach cut off three inches of a strangulated bowel, and reunited the gut by the interrupted suture; the patient remained well for several weeks, and died of other internal strangulation. The wound was found cicatrized.

II. THE UNINTERRUPTED SUTURE.—a. *Ordinary Glover's Suture.*—The two edges of the wound are brought together and held at either end; a needle armed with waxed thread is then passed obliquely through the edges, beginning from about a line from one of the angles. The thread is drawn through to within four or five inches of its extremity, and the needle again repassed in the same way, traversing the wound with the same obliquity, passing the thread over as in the whipping-stitch; this to be done as often as is requisite to complete the union of the wound, taking care to leave three or four inches of thread at the termination. The two ends of the suture are confided to an assistant, and the intestine returned into the abdomen, when these ends of the threads are to be drawn tightly outwards, so as to appose the intestine to the internal surface of the external wound. The thread may be withdrawn five or six days after, and this is to be accomplished by cutting one end close to the parietes and gently pulling the other. Some prefer cutting both ends off after fixing them, and leaving the suture to find its way into the bowel if it can.

b. *Reybard's Modification.*—An ordinary sewing-needle is armed with a double thread, the free extremity of which bears, instead of a knot, a little roll of linen, one-fourth of an inch long. The thread is greased with oil or cerate. The suture is commenced by piercing from within outwards the edge of the wounded gut, near one of the angles, drawing the thread through, and leaving the roll of linen within the intestine; then the edges of the wound are to be brought together, and both sides pierced at once, and the suture continued as in the ordinary process, excepting that the points of suture are to be nearer together, and tightened a little more. In order to fasten the threads at the termination, the needle is to be passed back under the last stitch but one; then one of the threads is to be cut, and the last point of suture to be finished with a single thread; then the two threads are tied together, and the ends cut off close to the wound.

The ordinary method is the one generally adopted, and many experiments have been performed with this suture by Moebius, Shipton, Brewer, Thompson, Sir A. Cooper, Travers, Reybard, Pétrequin, and others.

Dr. Gross performed 17 experiments with this suture. In 2 the bowel was wounded transversely (in one completely divided); in 12 the wound was longitudinal, varying from half an inch to six inches; in 3 the wound was oblique. All the animals experimented on recovered, but 3 of them were killed too soon after the operation to allow of any positive conclusion as to the ultimate effects; in 8 the needle was carried through the whole thickness of the bowel, and in 5 the everted mucous membrane was pared off on a level with the surrounding surface; in 8 the suture was inserted through the fibrous lamella, or between the muscular and mucous coats; in 1 through all the layers of the tube, except the peritoneal.

Of these three methods, that of introducing the suture through the cellulo-fibrous lamella is the least objectionable, as it enables the serous surfaces to be brought into the most accurate apposition. The earliest date of passage of the thread into the bowel was on the thirty-fifth day; in other instances it was found partially adherent on the twenty-second, twenty-eighth, and thirty-first days. Gross, as well as Reybard and Pétrequin, dwells upon the importance of taking the stitches very close to each other, and of drawing them firmly in order to insure union. M. Moreau-Boutard has proposed to sew wounds of the intestine by excising the everted mucous membrane, and bringing the peritoneal coat and the exposed submucous tissue into contact, and he effects this object by passing the suture through the submucous cellular tissue. Dr. Gross gives six cases where the glover's suture was used, two only of which were fatal. Guy de Chauliac mentions a successful case in which he sewed intestines "vulnerata secundum longum et latum cum sutura pelliperiorum." Fallopius records a similar case. Garengeot[1] mentions a patient operated on by Guerin on whom this suture was used, but whose death took place on the third day.

Reybard read before the Académie de Médecine the case of a man, aged twenty-eight, who labored under a carcinomatous tumor of the sigmoid flexure of the colon; having diagnosed it, he cut into the abdomen, removed three inches of the intestine affected with the disease, tied the arteries of the mesocolon, and united the extremities of the divided bowel with the glover's suture; the suture was cut short, the intestine replaced in the abdomen, and the wound in the parietes sewed with three stitches. On the tenth day a copious evacuation was passed *per anum*, and on the thirty-eighth day the patient was pronounced well. After the lapse of six months, symptoms of cancerous disease of the intestine again set in, and the patient died twelve months after the operation. No autopsy could be obtained. Another remarkable case of recovery is quoted by Guthrie, viz., the case of Richard Cain, under the care of Mr. Jenkins, of Gosport.

c. *Method of Bertrandi*, or suture "*à points passés*," a variety of the continued suture. This has been recommended by Boyer, Sanson, Roux, Patissier, Lombard,

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[1] Traité des Opérations, etc., 2e éd., tome i. p. 191. Paris, 1731.

Richerand, and others. The lips of the wound are held together, and pierced obliquely about two lines from the free edge; the thread is drawn through, and the needle is then repassed in the same way, on the same side which it has just quitted, about two lines further on, and this is continued on from one side to the other till completion, just as a tailor bastes two pieces of cloth. The intestine is then reduced, and the two ends of the thread fixed outside. These may be withdrawn some days after by cutting one end and pulling the other. Lombard successfully used Bertrandi's suture in 1778.

Modification of Béclard.—He arms the needle with two threads, one white and the other colored, so that when they require to be withdrawn the white thread has to be pulled at one end and the colored one at the other.

d. M. Hippolite Nuncianti, of Naples, has suggested a suture, called the *spiroidal*, which is nothing more than a variety of the continued. The serous surfaces of the lips of the wound are inverted and brought into contact. The suture is a single thread, which is carried along the wound alternately from left to right and from right to left in a spiral manner, and then by pulling the extremities of the thread, one at each angle of the wound, the lips of the wound are inverted and brought into contact. M. Nuncianti relates three successful cases.

It will be seen that the object of the continued suture is to produce absolute contact of the edges of the divided bowel in their entire extent, so as to prevent the danger of effusion. In doing this, however, we multiply and add to the danger of the wound and the risk of further ulceration. At least such is the argument raised by those who oppose the use of this suture. Many experiments and cases have been detailed to prove that it is not essential that absolute contact of every part of a wounded bowel should be secured in order to prevent effusion. Mr. S. Cooper gives the following strong recommendation: "Notwithstanding I have carefully read all the arguments adduced by Mr. Travers, in favor of stitching a divided bowel at as many points as possible, I still remain unconvinced of the advantage of such practice. If a case were to present itself to me in which a bowel partly cut through protruded, I should apply only a single suture made with a small sewing needle and a piece of fine silk. If the bowel were completely cut across, I should have no objection to attach its ends together by means of two or three stitches of the same kind. I coincide respecting the advantage of cutting off the ends of the ligature, instead of leaving them in the wound, as they act as extraneous substances."

Before entering on our next consideration respecting sutures, we must just advert to two proceedings, which have been generally proscribed.

(1) *Process of M. Littre.*—After gangrene, he proposes to tie the inferior end of the intestine in order to effect its obliteration, and then to attach the upper end into the ring so as to establish an artificial anus which the patient is to retain the rest of his life. Louis finds this process attended with difficulty, viz., to know how to distinguish the upper from the lower portion of the alimentary canal. The operation is generally deprecated as establishing a disgusting infirmity.

(2) *Process of Lapeyronie.*—He passes behind the division a double thread through a fold in the mesentery, and, after having pushed back the two ends of the intestine into the ring, makes use of the thread to prevent their entering the belly completely, by attaching it to the outside upon the dressing in any mode whatever. The result is an artificial anus, which may close up spontaneously, or by the aid of art.

Scarpa objects to this proceeding, because the ligature, 1, presents an impediment to the gradual retraction of the parts; 2, must soon cut through the mesentery, and may at the same time divide the vessels, causing fatal hemorrhage; 3, may cause ulceration and perforation. His objections have not been confirmed by others, and the process itself has succeeded. Reybard relates a case where the colon protruded, and was wounded in two-thirds of its circumference. The intestine was replaced, unsewed, and was retained near the parietal wound by a suture through the mesentery; the patient recovered with an artificial anus.

When the intestinal tube is *completely* or *nearly completely divided across*, there are three chief methods devised for dealing with it.

I. UNION OVER A FOREIGN BODY.—It has been proposed and tried to unite the divided ends upon a foreign body, and several varieties of this method exist.

a. *Method of the Quatres Maitres*[1] (middle of the thirteenth century).—It is said that they commenced by procuring the windpipe of an animal, introducing one extremity of this tube into the upper end of the divided gut, and inserting the other into the lower end; and that they then approximated the ends of the two bleeding circles in order to adjust them, and kept them in contact by means of several points of suture.

Jamerius, Roger, and Theodoric supported the canal by a canula of elder wood.

William of Salicet recommended a dry, hardened bowel of some animal. Louis tried the method on two dogs, and they recovered.[2] Vogel tells us that a veterinary surgeon, in 1704, opened the abdomen of an ox affected with obstinate constipation; he cut away the mortified portion of intestine, and sewed the ends of the bowel over a tube of wood; the cylinder was soon voided *per anum*, and the animal lived several years.[3]

Dr. Watson, in 1790, excised a portion, four or five inches, of the bowel of a large dog, and sewed the divided extremities over a cylinder of isinglass; the animal perfectly recovered.[4]

b. *Method of Sabatier.*—Sabatier, Ritch, Desault, and Chopart substituted a piece of playing-card besmeared with essence of turpentine or oil of St. John's wort, or varnished in any manner whatever.

c. *Method of Duverger* (1745).—He used a portion of prepared calf's trachea, furnished with three loops of thread, placed at equal distances, each end being armed with a small curved needle. It was first put into hot wine, to make it more supple and warm, and afterwards steeped in a mixture of Commander's balsam and balsam of Peru. He then introduced it into the intestine in such a way that it supported the two ends, and by means of the curved needles he made three points of interrupted suture, passing them from within to without, three or four lines from the wounded edges; the knots were made at one side of the wound.

Duverger's case is probably the only authentic example of this plan succeeding in the human subject. He cut off a portion of mortified intestine, in a case of strangulated hernia, introduced a portion of the trachea of a calf, brought the divided intestine over it, and fastened it by a suture. The trachea was passed on the twenty-first day, and the external wound closed on the fortieth. The patient recovered. Sir A. Cooper repeated the experiment of Duverger; on the sixteenth day the animal was killed, and the union was complete.

d. *Method of Jobert* (1824).—When omentum presents itself in front of the bowel, he seizes a fold of it, interposes the fold between the edges of the wound, and then brings the lips of the wound together, uniting the whole by the suture of Ledran. At the autopsy there is found in the intestine a floating layer of omentum.

All these modes of trying to establish the continuity of the bowel by the introduction of a foreign body or tube, and uniting the intestine over it, are attended with so much difficulty and danger, and give such bad results, that their advocates have quite discarded them for the present.

II. UNION OF DIVIDED INTESTINE BY INVAGINATION.—a. *Method of Ramdohr* (1730).—Ramdohr, having under treatment a soldier, in whom the continuity of the intestinal tube had been destroyed, cut off a large part of the intestine, and joined the two sound ends together, by inserting the upper end within the lower one, and fixing them in this position by a point of suture moderately tightened, the ligature being also employed to keep them at the same time near the external wound. The patient recovered, and the feces continued to pass entirely by the rectum in the natural way. About a year after the operation he died of another affection. The parts were removed and sent to Moebius, who showed them to Heister. They exhibited, according to the latter author, union of the two ends of the bowel together, and their consolidation with a part of the abdomen. Heister made experiments on dogs in this manner, but without success. Moebius attempted to repeat Ramdohr's operation upon a dog, but he could not succeed in insinuating the upper part of the divided bowel into the lower one, on account of the contraction of the two ends of the intestinal tube and the smallness of the canal.

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[1] Four famous monks, who practised surgery together at Paris. The method was to unite the wound of the intestine by direct apposition of the divided edges, supporting the intestine by a firm cylinder introduced within it.

[2] Mém. de l'Acad. de Chirurgie.

[3] Sandifort, Thesaurus Dissertationum, etc., tom. ii.

[4] Medical Communications, vol. ii.

Dr. T. Smith, of Philadelphia, also tried this method, but could not succeed. He divided the intestine of a dog transversely, and having inserted a piece of candle into that portion which was supposed to be the uppermost, he endeavored to introduce the superior within the inferior, but the ends became so inverted that it was found utterly impossible to succeed. Hennen applied the glover's suture to the two ends thus invaginated. Vermale enveloped the ends of the intestine in a fold of the mesentery, which he comprised in the suture. Ritch placed in the bowel a varnished card rolled up; then invaginated and passed a loop of thread through the two ends of the intestine, and the cylinder of card at the same time, tied the threads two or three inches from the intestine, and secured them in the external wound.

Jobert traversed the anterior part of the upper end with a silk thread armed with two needles, and then passed these into the lower end from within outwards, when by gentle traction, he introduced one end of the bowel inside the other. This method appears to have succeeded in a very small number of cases. Boyer performed it in one case, where he had to divide the mesentery and tie seven or eight vessels, but the patient died from extravasation; in another case he could not complete the operation. Velpeau saw another case in which this procedure was attempted at the Hôpital St. Louis, but in which the patient died on the following day. MM. Lavielle, Chemery-Halé, Schmid, and some others, also relate instances of cure.

An interesting, successful case is recorded by Dr. Pilcher,[1] where the ileum was divided diagonally across, with two inches of the mesentery. Invagination was effected, the lower end being inserted in the upper, and maintained by three points of suture. The patient was well on the nineteenth day.

There are three great difficulties to be overcome in this operation:—

(1) To distinguish the upper end of the intestine from the lower. The only means proposed by Louis is to retain both ends outside, and administer a purgative; if the wound be in the large intestine, an enema is best.

(2) To insert the upper end into the lower. The difficulty to be overcome is the contraction of the lower end of the bowel, which may be avoided by seizing the principal diameters at their four extremities, with four forceps; then the upper end is to be grasped four or five inches above its division, and properly compressed and then invaginated.

(3) A mucous membrane is apposed to a serous one, and cannot unite with it. However, the union may take place by false membranes, and by means of adhesions with the surrounding parts.

b. *Method of Reybard.*—The surgeon first incises the mesentery to the extent of a few lines; he afterwards passes, a little above the wound, a thread, one end of which remains within the canal, while the other hangs outside. According to Reybard, two nooses thus adjusted will be found sufficient, that is, one on each extremity of the antero-posterior diameter of the gut. By the aid also of a needle we are enabled to pass the inner extremity of each thread from within outwards, and through the lower end of the intestine, in order to invaginate the two portions methodically, and to terminate by fastening each point of suture with a knot. Although Reybard has successfully performed the operation, he yet unreservedly condemns it, and points out its disadvantages and dangers in his Memoir on Artificial Anus.

III. UNION BY CONTACT OF THE SEROUS SURFACES.—a. *Method of Jobert* (1824). Jobert conceived the idea of putting the serous membranes in contact by means of a new kind of invagination. The upper end being well recognized, the patient is laid on his back, with the muscles of his abdomen as relaxed as possible, and the mesentery of each end is dissected off to the extent of nearly one-third of an inch. There is always some flow of blood, which need not be stopped, as it is an obstacle to inflammatory action. But if the hemorrhage is too abundant, temporary ligatures are applied, and removed after the operation. This first step finished, the surgeon seizes the upper end with his left hand; with his right he takes a thread five or six inches long, furnished with two ordinary needles, and traverses with one needle the anterior wall of the intestine from within outwards, two inches from the wound, in such a way as to leave in the puncture a loop, the two ends of which are confided to an assistant; a second thread is passed in the same manner across the posterior wall. Then abandoning the upper end, the surgeon proceeds with his finger, or still better, with the dissecting forceps, to double the lower end inside itself, so that the serous membrane is on the inside. Having done this, the left index finger is introduced to sustain it and serve as a conductor for the needles. The two needles of the anterior loop are taken and passed in turn along the radial border of this finger from within outwards, through the double part of the inferior end, and brought out at a distance of one line from each other. The needles of the posterior loop are conducted in the same way on the ulnar side of the finger, traversing the intestine at that spot. The two ends of the intestine are then gently brought together, and when almost mouth to mouth, the finger is withdrawn; and on gently pulling the ends of the threads, with the aid of a round, polished body, the upper end is by degrees introduced into the lower. The intestine is then reduced into the abdomen, and the threads twisted together, brought out at the lower angle of the external wound, and fastened to the parietes by plaster. On the fourth or fifth day the cicatrix is formed, and the threads may be withdrawn. Jobert relates two cases of this operation;[1] both patients died within a few hours. Dr. Gross, and MM. Bégin, Reybard, and Pétrequin have made experiments with this method. It is generally deprecated on account of its difficulty, the violence done to the parts, the uncertainty of its results, and the impossibility of distinguishing the lower extremity of the intestine with certainty.

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[1] American Journal of the Medical Sciences, vol. xlii.

b. *Method of Denans* (1826).—The surgeon employs three small hollow metallic cylinders. He places one in each end of the intestine; after which a portion of each end is doubled into its respective cylinder. The third cylinder, which is somewhat smaller, is then introduced inside the two others, in such a manner as to act as a rod, axis, or support to both. A noose of thread embraces them, and secures all the three on two different points of the intestinal circle. The ends of the suture are divided near the peritoneum, and the whole is returned and left in the belly. The agglutination of the parts soon takes place; everything which is pressed between the three cylinders becomes gangrenous and detached, and the rings, becoming free, are carried off by stool. Denans simplified this process still more by doing away with the sutures, which he found unnecessary. Who would venture to leave the intestine in this manner in the belly? Who would guarantee that the metallic tubes would not perforate the intestine?

c. *Method of Lembert* (1826).—The surgeon passes with a needle as many nooses of thread as he wishes to make points of suture, first through the thickness of the walls of the upper end of the bowel and afterwards through those of the lower end. He introduces the point of this needle upon the external surface of the gut at the distance of two or three lines from the wound, causes it to make its way through the tissues as far down as the mucous membrane, brings it out at two lines distant from its place of entrance, and succeeds in this manner in adjusting his noose of thread. He then applies his needle with the same precaution upon the external surface and into the tissues of the rectal end of the bowel. He introduces successively and in the same manner the number of threads which he deems advisable, and afterwards knots them in order to complete the suture. By making traction upon nooses of this kind, the lips of the wound are compelled to become reversed upon their internal surfaces.

Dr. Gross performed 23 experiments with this method, but has deduced no conclusion, nor given any analysis of the results. In 9 animals the bowel was completely divided, and 4 died; two with fecal effusion. The results of the experiments on partial wounds of the bowel with this suture were very favorable; one dog only perished. They also tended to show the rapidity with which single points of suture passed into the bowel.

Cases in which this suture has been used:—

1. Jobert: Recovery. See Velpeau, Méd. Opérat., tome iv. p. 143.
2. Dieffenbach: Death from other causes. Brit. and For. Med.-Chir. Rev., vol. iii. p. 517.
3. Jobert: Recovery. Archives Gén. de Méd., Mars, 1837.
4. Baudens: Recovery. Clinique Chirurgicale.
5. Baudens: Death. " "
6. Liégard: Result not stated. Velpeau. Méd. Op., tome iv. p. 143.
7. Jobert: Death. Archives Gén. de Méd.
8. " " " " "

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[1] Archives Gén. de Médecine, 1824.

M. Roux, in endeavoring to remedy an intestino-vaginal fistula, opened the abdomen, divided the intestine in two places immediately above and below its point of adhesion to the vagina, as he thought, and united the extremities by three points of suture according to Lembert's method. The operation lasted one and one-quarter hours, and the patient died in thirty-eight hours. On dissection, it was found that the ileum had been divided two and a half inches above the artificial anus, but that, instead of dividing the small intestine below that point, the operator had severed the sigmoid flexure of the colon and sewed the small intestine to the end of it.[1]

d. *Method of Gély* (1844).—This is a modification of Lembert's method, to which M. Gély raises the following objections, viz., (*a*) that it does not securely close the wound unless the points of suture are tolerably near together; and (*b*) that the danger of inflammation is necessarily increased with the number of stitches.

Gély remarks that a suture ought to possess the following points of recommendation: (1) to so thoroughly close the wound as to obviate all danger of either immediate or secondary effusion; (2) to present such an arrangement that neither the knot nor any portion of it is visible on the peritoneal surface; (3) to certainly pass into the intestine; (4) to be easily executed and applicable in every case.

The suture recommended may be practised with one or two needles, two preferably; they should be fine, but a little larger than the thread. One of them is inserted parallel with the wound, outside and a line or so behind one of the extremities of the wound, is carried for two or three lines into the cavity of the intestine, and is then brought out on the peritoneal surface again; precisely the same is done with the opposite needle; the threads are then crossed, the left needle is now introduced into the puncture, through which the right needle has just passed, and a stitch similar to the first made is taken with it; and a like stitch is made in a like manner with the right needle. As many stitches are thus made, parallel to each side of the wound, as its extent may require; and it then only remains to tie the threads and tighten the stitches sufficiently; this is accomplished by pulling the threads with dissecting forceps at each point where they cross the wound, at the same time inverting the lips of the wound, which soon become so perfectly coaptated that the thread is completely concealed between them; finally, the extremities of the thread are knotted and cut close, and the knot is as effectually concealed as the rest of the suture.

When the needles are crossed, it is not indispensable to pass them exactly into the orifice which the opposite one has traversed; and it both facilitates and hastens the operation to tighten and knot the threads each time that they are crossed. An essential point is to make the corresponding stitches at the opposite sides of the wound of equal length, as otherwise the wound would be puckered. M. Gély's experiments on animals are scarcely sufficiently numerous, but as far as they go they are favorable to this method. He has twice successfully applied it in the human subject. A sailor received a wound in the left lumbar region, through which twenty-seven and a half inches of bowel with a portion of omentum protruded. After exposure and constriction by the abdominal parietes for two hours, two small wounds in the protruded gut were secured by the above suture, and the intestine returned. The patient recovered without any serious symptom in twenty days.[2] In the second case, a small wound was inflicted on the intestine during the operation for strangulated hernia. Gély secured the wound with a stitch of his suture, and returned the intestine. The patient recovered.[3]

e. *Method of Amussat* (1834).—This surgeon has experimented on animals by placing in the intestine a narrow piece of cork, expanded at its ends and narrowed at its centre, so as to present a central groove or furrow. The two ends of the intestine are then invaginated, so that both cover the cork, and are tied on it tightly with a strong thread; and all that portion of intestine passing beyond the ligature is cut off with scissors.

Malgaigne remarks that there is something astonishing in this proceeding, and that before trying it on the human subject it requires further meditation and experiment.

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[1] Recueil de Mém. de Méd., etc., tome xii.

[2] Annales de Chir. Nos. 48, 49.

[3] Prof. Emmert, of Berne (1862), has proposed a plan which combines the stitch of Lembert with the loop of Ledran and the darning point of Bertrandi. He considers that it obviates the chief objection to Lembert's and Gély's methods. Dr. Vézien, of Paris (1871), employs the interrupted suture, knotted within, instead of on the outside of the bowel.

f. The other varieties are merely speculative proposals which we do not feel justified in recording.

Such, then, are the endless varieties of methods proposed for applying sutures to wounded intestines. Their merits may be summed up in a very few words. In partial wounds, the ordinary interrupted suture is the best. In complete division, or nearly so, three proceedings have each met with great success: (1) the ordinary interrupted suture; (2) the ordinary uninterrupted suture; and (3) attachment of the gut to the external wound. The first two are to be preferred; but experience and facts have not as yet decided their value relative to one another. With the third, we run the risk of establishing an artificial anus.

Retro-peritoneal Extravasation and Suppuration.

Extravasation into the sub-peritoneal or retro-peritoneal tissues may be either of air, blood, urine, feces, or pus.

Air.—The source of the air is not always traceable, but its distribution is often very extensive. In a case already alluded to,[1] of rupture of the ileum just at the entrance of a hernial sac, there was a large quantity of air behind the peritoneum of the pelvis and both loins, and it had diffused itself along the vertebræ behind the diaphragm, into the posterior mediastinum and thence to the neck, from which it spread downwards, guided by the cervical fascia, to the shoulders, arms, and pectoral regions. All these parts were distinctly distended with air, and crepitant to the touch. The source of the air could not however be traced: there was no injury to the lungs, and the possible and only apparent source was a perineal incision which had been performed on account of a rupture of the urethra complicated with fracture of the pelvis.

In an interesting case under the care of Dr. Cayley, in the Middlesex Hospital, of aneurisms of the cœliac axis and superior mesenteric artery, for the treatment of which compression by means of the abdominal tourniquet had been employed, there was extensive emphysema in the cellular tissue behind the ascending colon. The small intestines were ecchymosed, and at one spot the coats were thinned, and there was some submucous emphysema. The large intestines were normal. It is quite possible that the air in this case had simply transuded into the retro-peritoneal tissues through the thinned walls of the ileum. Wounds of the loins, groins, and perineum, whether complicated with wounds of the bowel or not, and fractures of the lower ribs with lung-injury, may be the cause of this form of extravasation. Decomposition may in some cases explain the presence of gas. Retro-peritoneal abscess opening into bowel may of course give rise to it.

Blood may be effused as the result of injury from an artery (as in a case already mentioned of ruptured mesentery and inner coat of the aorta), from a vein, or from capillaries. Violence inflicted upon the loins or pelvis is very likely to cause extensive extravasation of blood into and beyond these regions, and the hæmatoma so formed may, after a varying period of from several days to some few months, break down and suppurate. One might refer to many cases in which most extensive retro-peritoneal hemorrhage has ensued from fracture of the pelvis or lumbar spine. Injuries to the loin are sometimes followed by extravasation beneath the capsule of the kidney, as well as into the abundant peri-renal cellular and fatty tissue, without, it may be, any rupture of the capsule or distinct laceration of the renal substance. Some of the most frequent hemorrhages into the pelvis are those which are known as "sub-peritoneal, or encysted, pelvic hæmatoceles:" in these cases a vaginal or rectal examination will reveal a soft, smooth, and elastic or fluctuating mass in the pelvis, fixing or displacing the uterus, the os and cervix of which may be flattened against the symphysis pubis, or against the front of the abdominal wall immediately above the symphysis. As the extravasation increases, there are fulness, dulness, tenderness, and a sense of resistance in one or both iliac fossæ, or in the hypogastric region, and extending sometimes even as high as the umbilicus. There is too in these cases a sense of bearing down about the pelvis, with frequent desire to evacuate the bowels and bladder, though nothing but mucus passes from the rectum, and retention frustrates the frequent desire to micturate. Occasionally the posterior vaginal wall is pressed down as low as the perineum, or may even be prolapsed, by the enormous extravasation beneath the peritoneum in Douglas's pouch.

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[1] See contusion and rupture of hernia.

After some days the effused blood becomes more solid, and the tumor more irregular, and it is by degrees absorbed; or after becoming harder, partly from coagulation and partly from inflammatory effusion around it, it may disintegrate and be even softer than when first poured out. Under these circumstances, the symptoms of retro-peritoneal suppuration will arise.

The sources of blood vary in the different regions; but everywhere the retro-peritoneal tissues are rich in bloodvessels, and the anastomoses between the vessels of the parietes and those of the viscera are numerous and important, both in the loins and pelvis. The rupture of muscular tissue, such as that of the psoas, iliacus, and quadratus lumborum, is occasionally the cause of very free hemorrhage. Sometimes the blood is derived from one of the venous plexuses, namely, the uterine, ovarian, hemorrhoidal, vesical, or prostatic, or from the trunks or branches of the arteries to those organs.

The rupture of an aneurism of the abdominal aorta is an occasional source of most extensive retro-peritoneal hemorrhage. The extent of the effusion in such cases is sometimes astounding, for the blood by degrees dissects up the peritoneum, and permeates the cellular tissue in every direction, causing the ribs and loins to bulge outwards; it may also carry forwards the posterior and lateral layer of peritoneum, and the abdominal viscera, so that the abdomen protrudes in front; and it descends along the psoas and iliacus until a fluctuating tumor is formed in each groin, even below the level of Poupart's ligament. There is usually not the least pulsation in such swellings, and unless the history of the case is known, the diagnosis is very difficult if not actually impossible. In some cases there may have been an attack of syncope to mark the bursting of the aneurism, but life may continue long after this, and the slow course of the disease, with the absence of every characteristic sign of aneurism, will probably lead to the supposition that the affection is malignant.

Erosion of the vertebræ from the pressure of the aneurism may give rise to more or less pain, or even to some degree of curvature, and then there is a risk that the swelling in the iliac region, or in the course of the psoas muscle, may lead to the diagnosis of lumbar caries with abscess. To open such a swelling on the supposition that it was an abscess, would of course be a serious, and might even prove a fatal, mistake.

Sometimes there is nothing to indicate the exact time at which the aneurismal sac has given way, though from the lamination of the clot found in the tissues after death, it is certain that the blood must have been effused gradually, and for many weeks, perhaps some months, before death. The extravasation has been greatest in the cases in which the aneurism has been seated at some spot above the superior mesenteric artery.

The mode of death may be from acute or chronic peritonitis, or from syncope, but more generally from anæmia—the blood extravasated being as really lost to the individual as if it had escaped through an open wound. Still, as the effusion is gradual, the downward course of the patient is gradual also; but day by day, week by week, the life and strength are slowly worn away. A few cases of ruptured abdominal aneurism leading to retro-peritoneal hemorrhage are recorded in the London Pathological Society's Transactions.[1]

In one of them[2]—a case which I had seen during life and examined after death—the enormous tumor had everywhere pulsated, nothing but skin and condensed cellular tissue formed its posterior limit, and in front it had ruptured into the peritoneum just above the cæcum. Dr. Habershon has mentioned to me a very interesting case in a gentleman under his care, whose death was very slowly brought about by the rupture of an abdominal aortic aneurism, and the gradual effusion of blood behind the peritoneum. A very similar clinical course and pathological condition occur in ruptured aneurisms of the thoracic aorta, as is shown by a case of my colleague Dr. Coupland,[3] and others.

Another cause of retro-peritoneal hemorrhage is ulceration by pressure of an abscess or a tumor. A case will be hereafter mentioned in which stricture of the œsophagus set up suppuration behind the diaphragm, and death resulted from hemorrhage from the aorta, the coats of which were ulcerated through just above the cœliac axis.

Urine may be extravasated into the retro-peritoneal tissue of the loin from rupture of the kidney or its pelvis, or from ulceration or direct wound of those parts, the result of operation or accident. Ulceration of the ureter from the pressure of a morbid growth has been known to give rise to urinary extravasation in the iliac region, as in the case of a man aged 67, who was admitted under Mr. Clark's care into the Middlesex Hospital, for a large sarcomatous tumor the size of a cocoanut, between the rectum and bladder, beneath the peritoneum. The tumor invaded the bladder, and caused complete ulceration of the right ureter about two and a half inches above its lower end. The ends of the ureter were ragged and sloughy, and there was a quantity of brownish fluid and sloughing cellular tissue beneath the peritoneum in the right iliac region. Into the sub-peritoneal tissue of the pelvis, urine escapes from the bladder after rupture; or through an ulcerous or fistulous opening caused by syphilis or other necrotic process, arising either from within or outside the bladder walls. When urine escapes from the kidney into the loin, it diffuses itself widely, and may displace the over-lying viscera—liver, spleen, etc.—pushing them considerably forwards.

The inflammation excited may run on to suppuration, with pointing in the loin or groin, or the cellulitis may stop short of suppuration, and become chronic in character, spreading slowly towards the iliac fossa and brim of the pelvis, and causing contraction of the ilio-psoas muscle. Under these circumstances, a firm, hard swelling will remain in the iliac or lumbar region for many months, but may ultimately clear up, and the muscular contraction will yield to shampooing or one of the many modes of making extension. In some instances the effused urine becomes encapsuled within a thick-walled cyst of inflammatory formation, and with the cavity of this cyst, which may contain pus as well as urine, the kidney communicates at its point of rupture or ulceration. The urine contained in this false cavity is sometimes very dilute, and it has been supposed that this is the reason why the destructive changes which so generally follow urinary extravasations are sometimes escaped. It is not a fact, however, that the urine which escapes from a ruptured kidney is as a rule deficient in urea, and therefore less irritating than normal urine.

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[1] See especially vols. xix., xxi., xxii., and xxxiv., in the last of which a striking case is recorded by Dr. Silcock.

[2] Trans. Path. Soc. Lond., vol. xxii. p. 104.

[3] Ibid., vol. xxiv. p. 54.

On the contrary, there are cases in which it has been shown that urea has been in excess. Mr. Bennett May[1] has put on record an interesting case in which the effused urine was exactly like that passed by the urethra; and Prof. Marshall[2] has quite recently published one in which the fluid withdrawn from the loin contained 5.5 per cent. of urea, which is greatly in excess of that in healthy urine. There is, however, good ground for believing that urine, when not putrid or purulent, and if not extravasated in very large quantity, does not necessarily excite suppuration or sloughing of the tissues outside the peritoneum; nor when in its cavity does inflammation of the peritoneum always arise. Recorded cases of injured kidney show that the urine sometimes escapes very slowly into the tissues around; and days or weeks, or even months, may elapse before there is any local swelling sufficient to suggest extravasation, and without hæmaturia or other urinary symptom to indicate renal lesion.

After rupture of the bladder, urine diffuses itself more or less widely in the pelvis, or passes upwards into the iliac fossa, or spreads along the front wall of the abdomen—from which the peritoneum may have been largely detached by the injury—nearly as high as the umbilicus, or may penetrate along the course of the obturator vessels into the thigh. Acute peritonitis, too, generally occurs, and leads to death in a few days; but pus may form and be discharged into the peritoneal cavity, the bladder, or the rectum, or through fistulous openings in the abdominal wall. I have had two cases of recovery after rupture of the bladder, in one of which the abscess burst into the bladder,[3] and in the other into the rectum.[4]

Feces escape into the retro-peritoneal tissues from the ascending and descending colon, the cæcum, the sigmoid flexure, the rectum, and the second and third parts of the duodenum, as the consequence either of injury, or of ulceration from disease. Feces may also escape from any other portion of the bowel, if adhesions have fixed it to the parietal peritoneum, through which the intestinal contents will then pass, should perforation occur.

Cancerous, tuberculous, dysenteric, and other forms of ulcer; simple inflammation followed by ulceration; obstruction followed by ulceration or sloughing; and abscess opening into the bowel, are the common causes of fecal extravasation. As in the ischio-rectal fossa, so in the loin, groin, pelvis, or back, an abscess may form in the loose cellular tissue and open into the intestine, and subsequently fecal matter may be extravasated into the abscess. Sub-parietal ruptures and penetrating wounds are also occasional causes.

In long-standing cases a fecal abscess may open externally, as well as into the intestine. The following case, which was under the care of Dr. Coupland, in the Middlesex Hospital, is a good example:—

R. J., aged forty-five, had in the left lumbar region a fistulous opening, 1½ inches in length, and communicating directly with a fecal abscess. The liver was adherent to the diaphragm by numerous firm, fibrous bands, and the left edge of the left lobe was firmly adherent to the stomach, spleen, and abdominal wall. The stomach contained fecal matter, and 5½ inches from the pylorus there was a perforation by which it communicated with a large fecal abscess in the left hypochondrium and lumbar region, behind the peritoneum. The colon was normal up to 2½ inches below the splenic flexure, where its outer wall was wanting, and the bowel thereby opened into the fecal abscess. A fistulous track, as large as the forefinger, led from the abscess downwards behind the peritoneum to the pelvis, where an ulcer of the rectum had perforated and caused the initial extravasation of fecal matter, which had thus spread in an upward direction.

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[1] Brit. Med. Journal, Jan. 20, 1883.

[2] Lancet, May 26, 1883, and Med.-Chir. Trans., vol. lxvi.

[3] Med. Times and Gazette, Nov. 1879, p. 603.

[4] Lancet, July, 1883, p. 14.

Unfortunately, the diagnosis and relief of these conditions when situated high up, are not as easy as in the case of an ischio-rectal abscess; the mischief is often terribly far advanced before its cause is even surmised, and death ensues from septic absorption, hectic, or peritonitis. When a fecal abscess has been recognized and properly treated, by laying it open, irrigating, and draining it—or when it has spontaneously ruptured into the bowel or bladder—the prognosis must largely depend upon the cause of the extravasation. If due to simple ulceration, to violence, or to suppuration the result of violence, and beginning outside the bowel, there is hope of recovery, even without a permanent fecal fistula. On the other hand, if the extravasation have originated in cancer or tubercle; from complicated adhesions resulting in obstruction; from some disease behind the peritoneum, such as caries of bone, pancreatic calculus, or wide-spread suppuration in the cellular tissue arising from some inveterate disease of the uterine appendages, there is no probability of recovery. The destructive processes will continue and extend, and though death may come slowly, it will come surely, from blood-poisoning, exhaustion, or acute general peritonitis, due to the bursting of the abscess into the cavity of the peritoneum. It is unnecessary to dwell upon the various symptoms which may arise, and the differences which occur in fecal extravasations, as these resolve themselves into the symptoms of retro-peritoneal abscess.

Pus is sometimes extravasated into the retro-peritoneal tissue from some neighboring part, such as the pleural cavity, the sheath of a muscle, a hepatic, renal, or cystic abscess, etc., or from beneath the periosteum of a carious bone. But though in these cases suppuration does not originate in the retro-peritoneal cellular tissue, yet when once there, it lights up fresh suppuration, and, therefore, purulent extravasation may fitly be considered under the head of retro-peritoneal suppuration.

In fact, all forms of extravasation are liable to excite retro-peritoneal suppuration, but the probability of their doing so varies. Thus, whilst the tendency of blood to become absorbed, is, in comparison, considerable, and its tendency to break down and cause suppuration but slight; the tendency of urine to be absorbed is slight, and to excite suppuration considerable; whilst extravasated feces will surely provoke suppuration, though sometimes only to a limited extent, and in the form of a small fecal abscess with thick surrounding walls, instead of in a diffused manner and over a large area.

RETRO-PERITONEAL SUPPURATION.— *Causes.*—Retro-peritoneal suppuration may arise from blows and wounds, and other forms of external violence; from sprains of muscular or fibrous tissues; from cold, and various conditions of the blood, such as occur in fever; and from all the forms of retro-peritoneal extravasation and their causes. Necrosis of the ribs, vertebræ, sacrum, or innominate bone; suppuration of the retro-peritoneal lymphatic glands; the burrowing of pus through the foramina of the pelvis in hip-joint disease, from an abscess of the liver, gall-bladder, pancreas, or spleen, or from an empyema or pulmonic abscess, may each give rise to it. Suppuration about a stricture of the œsophagus, or within the pelvis of the kidney, whether from impacted calculus, cancer, or tubercle; the rupture of a renal cyst; hydatids; and disease of the uterus or its appendages, of the bladder, or of the intestine, have each their share in its causation. Ulcer of the duodenum should be specially mentioned, and so might ulcer of the rectum, typhlitis, and perityphlitis. Operations about the urethra, prostate, bladder, rectum, scrotum, testis, and spermatic cord, are prone to excite retro-peritoneal suppuration, on account (1) of the sub-peritoneal connective tissue; (2) of the venous connections of these parts; and (3) of the associate nervous influences.

Lastly, puerperal inflammations are frequent causes of widespread suppuration in the cellular tissue of the abdomen, as well as of the pelvis.

Symptoms.—These vary according to the cause and situation of the suppuration, and as to whether it is acute or chronic in character. They closely resemble the symptoms which are caused by the localized suppurations within the peritoneal cavity. The acute form begins with febrile symptoms—rigors, high temperature, quick pulse, loss of appetite, intense thirst, frequent sickness, headache, and constipation; followed by night sweats, great weakness, and pain and tenderness in the affected region, which any movement and some positions of the body aggravate; the countenance assumes a pinched, anxious, sallow, and sometimes a cadaveric expression; emaciation becomes extreme; and the abdomen gets hard, swollen, painful, and tympanitic. Local peritonitis is apt to arise, and septicæmia or pyæmia to set in.

Chronic or subacute suppuration commences very insidiously; the abscess may take years to form, and it often proceeds far before the symptoms are sufficiently pronounced to lead to an accurate diagnosis. There are a feeling of malaise, with more or less dyspeptic troubles; obscure rheumatic pains; a sensation of fulness, or aching, with, perhaps, an ill-defined tumor in the affected region; and some tenderness on deep pressure. Possibly the most marked symptoms, for a time, may be the ordinary indications of spinal disease; or simply some œdema of one leg or foot, of some part of the abdominal wall, or of the scrotum or vulva; or a pain felt along the course of one of the nerves which traverse the abdominal or pelvic wall, such as the ilio-inguinal, ilio-hypogastric, external cutaneous, or obturator, or a feeling of numbness along the course of one of these nerves. If the suppuration be in the pelvis, and especially if connected with the left broad ligament, a tense constriction may form about the rectum, and give rise to the symptoms of stricture of that part; or the only marked symptom may for a time be an abundant discharge of mucus, suggestive of dysentery or obstinate diarrhœa.

As suppuration becomes more established, the evening temperature keeps high, night-sweats occur, and the symptoms generally are more like those of the acute form. Pain and irritative fever may be severe, redness and œdema of the overlying skin are noticed, and gaseous crepitation in the underlying tissues may be detected—as in a case lately under my own care, in which an abscess pointed above Poupart's ligament, was very crepitant, and when opened gave exit to most stinking pus, and in which a drainage tube could be passed far inwards to the pelvis; œdema of the scrotum was also a very noticeable feature in this case.

There is often more or less disturbance of the viscera in the immediate vicinity of the disease; so that retro-peritoneal inflammation resembles disease of the organs within the peritoneal cavity which sympathize in the external inflammation. Thus we find that suppuration around the cæcum, or the sigmoid flexure, simulates inflammation of those parts; constipation and distension arise from suppuration around the ascending or descending colon; indigestion, flatulence, or gastrorrhœa and acute dilatation[1] of the stomach, may be caused by an abscess behind the duodenum; pleurisy or pleuro-pneumonia may be caused by an abscess below the diaphragm, or about the upper part of the kidney, liver, or spleen; jaundice may appear, and abscess of the liver be suspected, from suppuration behind the liver; and empyema, hydatids, disease of the spleen or gall-bladder, renal or spinal affections, ovarian or uterine disease, may, according to the part of the retro-peritoneal connective tissue most involved, be simulated by or mistaken for suppuration outside the peritoneum. Occasionally, a large abscess cavity is formed in the lumbar and iliac regions, limited in front by the colon and cæcum, or sigmoid flexure, and behind by the lumbar and iliac fasciæ; the nerves of the lumbar plexus may be dissected out from the place where they leave the spinal canal, and lie loosely in the suppurating space; the iliac vessels or the vena cava, lying to the inner side or in front of this cavity, may become ulcerated, or may slough, and sudden death from hemorrhage may occur. When such an abscess has already opened into the bowel, the blood has been known to hurry through the suppurating space, and, finding its way into the gut, to be discharged in large quantities through the anus.[1] Dr. Goodhart has related to me the following very interesting case:—

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[1] C. Hilton Fagge, Guy's Hosp. Reports, 3d series, vol. xviii. p. 4.

A military officer had, for a year or more, occasionally experienced difficulty in swallowing, and at these times required a quantity of fluid to "wash his food down." He at these times emaciated rapidly, losing a stone or two in weight, but as quickly recovered as soon as the attack passed off. In the intervals, however, he often suffered pains about the epigastrium, and had a sense of distension after eating. On several occasions he had had shivering and feverish attacks like ague, and as he had been in the Ashantee War, it was supposed that they were due to some malarial influence, and that his liver might be affected. On one occasion, as he was about to leave his house, he felt a sudden faintness, and pain in his epigastrium, and vomited a little blood; the vomiting of blood was several times repeated, and within a day or two he was dead. A post-mortem examination revealed ulceration about a syphilitic thickening of the œsophagus, close to the stomach; this had set up suppuration in the surrounding tissues, and pus had burrowed behind the diaphragm, and had caused ulceration into the aorta, close to the cœliac axis.

In other cases, the pus strips up the peritoneum as it spreads, and sets up local peritonitis, leading to adhesions of the omentum and small intestines, to thickening of the capsules and walls of the viscera, or to intra-peritoneal suppuration; or thrombosis of the renal, iliac, or pelvic vein, or even of the vena cava, arises, and causes great œdema of the parts below, which send their blood back to the heart through these channels. In some chronic cases, the abdomen may be gradually enlarged by the increasing pus until the swelling simulates ascites. Mr. Barton has recorded a case[2] in which spinal caries led to a large retro-peritoneal abscess; dulness extended from ribs to pelvis on one side, and up to the median line in front, the intestines being pushed over to the opposite side; and the abscess pointed as far forwards as a line on a level with the anterior border of the axilla.

Diagnosis.—In the subacute or chronic cases, and even in the acute form, whilst pus is confined beneath the fascia of the abdomen or pelvis, there is much difficulty in the diagnosis. We must, by a careful investigation of the history and of all the circumstances of the case, take pains to estimate how much of the symptoms is due to mere sympathetic participation in, or secondary affection of, the pelvic or abdominal viscera, and how much to the retro-peritoneal mischief. The excretions must be carefully examined, the functions of each organ inquired into; and by a through scrutiny of the symptoms, on the principle of exclusion of diseases, we shall eliminate renal, spinal, hepatic, splenic, intestinal, vesical, uterine, and ovarian affections. When pus is being discharged in the urine, or by the lung or œsophagus, it may be difficult, if not impossible, without a very careful study of the chronological order of symptoms, to determine the correct relationship of the retro-peritoneal suppuration and the visceral affection, so as to say which is the cause of the other.

Prognosis.—If the pus makes its way to the surface, and is spontaneously discharged or evacuated through an incision, recovery ensues, unless blood-poisoning, hectic, or exhaustion carries off the patient. Sometimes the matter burrows far and wide between the muscles of the abdominal wall, or along the psoas and iliacus to the groin, or out through one of the foramina of the pelvis; or it may spread upwards to the diaphragm, or above it to the pleural or pericardial cavity; or between the great vessels in front of the spine and the prevertebral plexuses and cords of the sympathetic; or inwards to one or other of the hollow viscera; or through the peritoneum into the cavity of the abdomen or pelvis. An abscess in the pelvis may discharge into the rectum, vagina, or bladder, and be followed by recovery; or death may ensue from extensive and complicated burrowing and its consequences. A case was under the care of Dr. Coupland, in the Middlesex Hospital, in which, at the post-mortem examination, extensive suppuration was found in the pelvis, having been started by inflammation of the ovary; and the matter having burrowed beneath the peritoneum, ulcerated into the rectum and also into the bladder; it had also spread along the psoas, and discharged in the groin, and again had burst into the bowel at a higher point. Suppuration about the kidney may burst into the colon, pelvis of kidney, or peritoneum, or may take one of many directions. Thiersch had a case of perinephric suppuration, which by extension in one direction had caused empyema, and in the other a sinus on the front of the thigh. When the iliac region is chiefly affected, recovery may ensue after rupture into the cæcum or sigmoid flexure, or death after the matter has burst into the peritoneum. In cases in which suppuration has originated in disease of the vertebral column, the pus may open into both the colon and lung, so that it is both expectorated and voided with the feces. Even such cases are not always fatal, but recovery may ensue after a tedious convalescence, either with or without the establishment of a fistula.

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[1] Numerous cases illustrating some of these points are to be found in Dr. Habershon's work on Diseases of the Abdomen.

[2] Lancet, March 17, 1883, p. 453.

Treatment.—When inflammation or suppuration is known to exist, the treatment is, fortunately, quite clear, even though for a time a precise diagnosis as to the exact structures affected is impossible. Rest, leeches, warm sedative applications, attention to the digestive organs, the avoidance of sources of irritation to the bowels and kidneys, and of all unnecessary action or straining of the abdominal muscles, are necessary in the early inflammatory stages, whether the disease be external or internal to the peritoneum. When suppuration has taken place, the sooner a free vent is made for the discharge the better. There should be no delay in evacuating and freely draining a retro-peritoneal abscess, from whatever cause it has originated, or wherever it may be situated, more especially if the constitution is suffering from the pent-up matter. In all cases the pus should be let out through an external opening, if possible; but when it is distinctly pointing towards the rectum or vagina, no hesitation should be felt in making an opening through their walls. In very many cases the pus can be withdrawn through an aspirator. This instrument may have to be used again and again, at intervals of days or weeks, and ultimately a cure may result; or it may fail, and a cure will only be obtained by a free opening. I have had successful results with the aspirator in psoas abscess, after three and four aspirations, and I know of one case which was permanently cured after seventeen aspirations, lasting over a period of eighteen months. If the aspirating needle gets blocked with flakes of lymph or pus, it has been recommended to inject through it a drachm or two of tincture of eucalyptus, which is to be left in the abscess for a few days. It is stated that the flaky matter, by the solvent action of the eucalyptus, becomes fluid, and can then be easily withdrawn through the needle. In a large number of pelvic and iliac abscesses, an incision above Poupart's ligament, followed by free drainage, will bring about a cure; and lumbar abscess heals after an incision in the back. Mr. Frederick Treves, in a valuable paper read before the Royal Medical and Chirurgical Society of London, in January, 1884, has lately advocated an incision along the outer edge of the erector spinæ muscle in the treatment of psoas abscess and retro-peritoneal suppuration resulting from caries of the spine. By cutting through the sheath of the erector spinæ, and the quadratus and psoas muscles, the vertebræ are reached, and the anterior surface of the bodies of all the lumbar vertebræ can be explored. Mr. Treves details three cases in which the operation was followed by complete recovery, and in one of which a large sequestrum, measuring one inch by half an inch, was removed from the body of the first lumbar vertebra. Retro-peritoneal abscesses having a spinal origin may be treated in the same way.

I have found healing hastened, in some cases, by making the patient wear a Thomas's hip splint, so as to keep the thigh and trunk in line and prevent the action of the psoas and iliacus muscles; moreover, with this splint on, the patients are able to stand and move about, and thus the viscera are brought to bear upon the iliac and pelvic fasciæ, and tend to keep the abscess-surfaces in contact. A marked case was under my care two years ago, of extensive sub-peritoneal suppuration in the pelvis and left iliac fossa of a woman; free incisions and drainage above Poupart's ligament resulted in fistulæ, which would not close. For seven months a free purulent discharge continued unabated, the patient being meanwhile kept in bed; then a Thomas's splint was applied, and she was allowed to get up; in six weeks the abscess had completely dried up, and the fistulæ closed; but for four or five months the splint was worn to check the action of the ilio-psoas muscle. The patient has remained well since.

In some cases it would be best no doubt to make an abdominal incision, open and cleanse the abscess cavity, and stitch the edges of the incision into the abscess to the edges of the parietal wound. This has been done with marked success by Mr. Lawson Tait,[1] in twenty cases of suppurating, extra-peritoneal pelvic hæmatoceles, and there is no reason why the same treatment should not be applied with good results to many other cases of retro-peritoneal suppuration. The evacuation of pus by abdominal section would not be difficult, and, as compared with the risks of leaving such abscesses unopened, not dangerous; whilst rapid recovery would follow if the general cavity of the peritoneum were protected in the way suggested and practised by Mr. Tait. After pus from these retro-peritoneal abscesses has commenced to discharge, the strength of the patient requires to be maintained by tonics, nutritious diet, and stimulants; careful dressings and scrupulous cleansing of the wound, and attention to the condition of the bedding must be observed, so as to avoid bedsores and blood poisoning. As soon as possible the patient should be taken out of doors, and passive exercise in the fresh air encouraged. Even the daily change of room is advantageous in these, as in all other forms of purulent discharge. As the stench from some of these retro-peritoneal abscesses is very sickening and offensive, means should be taken to deodorize the discharges, and dressings of an antiseptic character should be used. I know of nothing more efficacious in correcting the condition of ill-smelling discharges, and in substituting a healthy odor in its place, than iodoform applied on lint, and in some cases covered over with the thinnest film of cotton-wool, so as to prevent contact of the drug with the skin or wound.

Retro-peritoneal associated with Intra-peritoneal Abscess.—Retro-peritoneal abscess may set up, or be set up by, or have a common origin and communicate with, localized collections of pus within the cavity of the peritoneum. This association is, perhaps, especially seen in that form of retro-peritoneal suppuration which originates in ulceration and perforation of the duodenum; but it occurs also from other causes and in other parts. An illustrative case was admitted under the care of Dr. Cayley into the Middlesex Hospital:—

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[1] Med.-Chir. Trans., vol. lxiii. p. 307; and Diseases of Ovaries, 4th ed., p. 344.

A draper's assistant, aged twenty-six, had enjoyed good health with the exception of a severe attack of epigastric pain about one year before admission. This had invalided him for six weeks. Six days before admission he was seized with acute pain in the stomach, which prevented him from walking home; it lasted all night, but abated in the morning, when he went to business again. In the evening, however, the pain recurred, and continued. The bowels were constipated, and he was sick. On admission, he had acute pain across the belly, and in the right iliac region; the abdomen was very tender, especially in the epigastrium, where there was considerable fulness also. A distinct resistance was felt in the right iliac fossa, which was dull on percussion; elsewhere the abdomen was tympanitic. In the course of a few days empyema and pneumothorax of the right side developed; an opening into the pleura was made, and was followed up by removal of a part of the eighth rib; sloughing spread upwards to the neck, and downwards to the crest of the ilium along the right side of the back; and death ensued within a month from admission. At the post-mortem examination, the edge of the right lobe of the liver was found adherent to the parietal peritoneum, and there was an abscess-cavity containing fetid gas, and about three ounces of purulent fluid. This cavity was limited on the inner side by the suspensory ligament of the liver, above by the diaphragm, and below and behind by the liver. It had two openings, one of which communicated with the duodenum, one inch from the pylorus, on its posterior wall, by a sinus one and one-half inches long which just admitted a probe, and which passed inwards to the gut beneath the edge of the liver. The transverse colon was firmly adherent to the liver and parts around, and helped to form one wall of this sinus. The other opening admitted a No. 12 catheter, was on the upper and outer aspect of the sac, on a level with the seventh rib, and connected the abscess-sac with the right pleural cavity. The walls of the sac were thickened, opaque, injected, and covered with false membrane. It had evidently existed a long time. There was general peritonitis. The right chest contained offensive pus, and the pleura was covered with greenish colored lymph. The opening into the chest between the seventh and ninth ribs communicated with the sloughing retro-peritoneal tissue in the back.

The clinical history of this case, read by the light of the post-mortem examination, points to ulceration of the duodenum as the cause of the suppuration in the cellular tissue behind that part of the bowel; and this in turn excited inflammatory adhesions about the colon, and inside the peritoneum, and the abscess-sac above described. All this took place in the illness twelve months before death; then came the fresh attack, which led to the bursting of the intra-peritoneal abscess through the diaphragm, and thus to the fatal empyema. In other somewhat similar cases, death has arisen from bursting of the abscess into the pericardium or peritoneum.

Fatty Tumors of the Abdominal Cavity.

A few cases of fatty tumor of large size, occupying a considerable part of the abdominal cavity, have been recorded. The London Pathological Society's Transactions contain three such, and in the Lancet for 1883, one was reported. They grow slowly and painlessly for a long while, but at length by their bulk cause abdominal tenderness, with loss of flesh and of appetite, and produce pressure upon vessels and viscera of the abdomen. They have been known to undergo both fibrous and osseous degeneration; and their removal during life has been attempted. They appear to grow from the peritoneum, are encapsuled, and have no connection with the surrounding organs. Their connection is sometimes with the back of the abdomen, where they fill the hollow on each side of the lumbar spine, and pass upwards and downwards from these localities.

They have no special symptoms. When of large size, and causing thereby trouble or danger, an attempt should be made to remove them by laparotomy.

Gastric Fistulæ.

Gastric fistulæ include fistulæ of the stomach opening into other hollow viscera, as well as those which open externally, and which, therefore, may properly be called gastro-cutaneous.

They may be divided into those which are the result of mechanical injury, and those which arise from disease. There are at least four kinds of mechanical injury which are known to have produced the external fistulæ, to which we here specially refer: 1, Incised, punctured, or lacerated wounds of the abdomen, penetrating the stomach. 2, Gunshot wounds, the shot either directly penetrating the stomach, and at once giving rise to the fistulous opening—as in the celebrated case of Alexis St. Martin, whose accident occurred in June, 1822, and who was known to be still alive and well, but with his fistula still unclosed, in 1873—or the fistula being subsequently established by the sloughing of the part of the wall of the stomach in contact with the wounded parietes, as in the case of Maillot, reported by Baron Percy,[1] and as in three cases recorded in the History of the War of the Rebellion,[2] in which the fistula followed the wound at periods varying from two to seven weeks. 3, A blow over the stomach, which, by causing an abscess in the parietes, has led to adhesion of the stomach, and in time—varying from a few weeks to several months—to a fistulous opening, the abscess-walls giving way both into the stomach and externally. 4, Ulceration from external pressure, as in the celebrated, self-inflicted fistula of Catherine Ross.[3] Though there are cases on record of knives and other foreign bodies, which, having been swallowed, have escaped, by forming abscesses, through the abdominal walls, it appears that the opening rarely becomes fistulous; and probably the wound in the stomach heals in some of the cases before the abscess opens externally. In one case,[4] however, the prong of an iron comb set up ulceration from within, and led to a gastric fistula.

Of the diseases which cause gastric fistula, only two are known, namely, cancer, and simple perforating ulcer of the stomach, either of which may give rise to it: (1) by gradual and continuous extension of the ulcerative process through the part of the abdominal parietes to which the affected portion of the stomach has become adherent; or (2) by first exciting around the ulcerated area a circumscribed abscess, which ultimately discharges its contents through the abdominal wall. The latter is, perhaps, the commoner mode; and as abscesses in the liver and in the abdominal parietes sometimes break into the stomach, it has been thought possible that some of the cases which have been described as simple gastric ulceration, may have originated in abscesses, which have opened externally as well as into the stomach. Fistulæ from disease are rarely seen in men, but nearly always in women. According to Murchison, gastro-cutaneous fistulæ are twice as frequently the result of simple ulcer as of cancer; this is the reverse of what has been found in gastro-colic fistula.

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[1] Journal de Médecine, t. iii. p. 510. 1802.

[2] Op. cit., Part II., Surg. Vol. pp. 52–53.

[3] Reported by Dr. C. Murchison, Med.-Chir. Trans., vol. xli. p. 11.

[4] Med. and Surg. Hist. of War of Rebellion, Part II., Surg. Vol. p. 53.

There are fistulæ which simulate the gastro-cutaneous; thus in Streeton's[1] case of multiple ulcer of the duodenum, immediately beyond the pylorus, food escaped as soon as it had been swallowed, from the external opening situated between the seventh and eighth ribs of the right side, just below the right mamma. In a specimen in Charing-Cross Hospital Museum, there is to be seen a specimen of cancerous stricture of the colon, with a communication between the duodenum and colon above the stricture, and another, through the abdominal parietes, with the surface near the umbilicus. In this case any fluid taken into the stomach passed at once from the duodenum into the colon, and thence within a few minutes to the surface.

The situation of the external opening depends, in traumatic cases, upon the situation and obliquity of the wound; in St. Martin's case it was between the left ribs, portions of which had been removed by the shot, and in Percy's case (Maillot) it was close to the ensiform cartilage; in Keith's case (Catherine Ross), the opening, which was transversely oval, was situated in the epigastric and upper part of the umbilical regions.

In cases resulting from disease, the place of external opening depends somewhat on the region of the stomach in which the ulcer commences; thus if the disease is near the pylorus, the external opening is generally near the umbilicus; if the ulcer is on the anterior surface, or near the fundus, the opening will be in the epigastric, or in the left hypochondriac region. The margins of the opening are generally hard and rounded; but when the fistula is caused by cancer, ragged or even gangrenous; sometimes the orifice is deeply retracted, so that it looks like a funnel. The skin around the fistula is usually red, tender, and even excoriated, owing to the irritation of the discharges. The size of the opening varies from something less than an inch to one and a half or two inches; in Catherine Ross it was four inches by three. It does not always remain of the original size: in some cases it increases; but generally, when there is a tendency to vary, it is towards narrowing. Upon the size depends whether the solid as well as the fluid contents of the stomach escape: if the opening is very small, fluids only pass out; otherwise, whatever is swallowed escapes, unless some artificial contrivance prevents it.

Symptoms.—It is remarkable how little the general health is affected by the fistula. The principal effects which have been recorded are thirst, increased appetite, obstinate constipation, deficient secretion of urine, and amenorrhœa. These symptoms are mostly traceable to the escape of ingesta from the wound, whereby thirst and hunger are excited, and the material which goes towards forming feces and urine is diverted from its proper channel. The fecal matter of these patients has in several instances been like the droppings of sheep, and only one stool has been passed in three, four, or even twelve days. The sense of hunger has sometimes amounted to actual pain. Vomiting appears to have been quite exceptional.

Prognosis.—In not a few instances patients have lived for many years with an open gastric fistula; in twelve out of twenty-five cases which Murchison collected from the records of Medicine and Surgery for 300 years, the fistula and existed for varying periods, from three years upwards. The length of time that a person may live with a gastro-cutaneous fistula depends on its cause; if due to cancer, the duration of life is of course short, from three weeks to several months; but if due to a simple ulcer, or to a wound, it may last for years. Though wounds of the stomach are mostly fatal, recovery occasionally occurs, either with or without fistula. A traumatic fistula may last a few months, and then close; or it may last as long as the patient lives—cases of four, eight, ten, and even fifty years' duration are recorded. The fistula caused by a simple ulcer may close up spontaneously and permanently; or, having closed, may re-open after a time; or may remain permanently open, and the patient live for seven, nine, twelve, or thirty years.

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[1] Lond. Med. Gazette, vol. iii. p. 43. 1829. (Case XVI. in Murchison's list.)

Treatment.—Although in several of the recorded cases the fistula has closed spontaneously, in only two out of twenty-five instances collected by Murchison does closure seem to have been the effect of treatment. In one of these, a fistula of ten years' duration was closed by making the patient keep quiet in her bed for some weeks. In the other, a cure was effected by keeping the edges approximated by means of the gradually increased compression of a circular bandage, feeding by the rectum, and preventing contact of the escaping contents of the stomach with the surrounding skin.

The indications for treatment are: (1) To prevent if possible the escape of the injecta. This is to be done by the use of a suitable, flat compress; not a plug, which does not effectually answer its purpose, whilst it tends to enlarge the opening. (2) To keep the surrounding integuments clean and as free from irritation as possible. To this end careful washing and drying, followed by the application of zinc ointment, of oxide of zinc in powder, or of oiled lint around the opening, are essential. (3) To encourage granulation and cicatrization of the edges of the wound by the occasional use of a stimulating application, and to make them approach one another as near as possible by the use of some well-adjusted, compressing bandage. In the case of Alexis St. Martin, the necessity of any compress to prevent oozing was after a time obviated by a slight protrusion of the coats of the stomach, and in other cases a similar natural plug has been formed. In no known case, except Middeldorpf's (1859), has any operative procedure succeeded. I can, however, see no objection to the proposal to attempt in suitable cases to close a gastric fistula by a flap of skin dissected off the neighboring part of the abdomen, turned with its cuticular surface inwards, and nicely fitted to the orifice, whose edges should have been previously freshened. No such attempt should, however, be made until nature's efforts have failed; and to facilitate union if such an operation is performed, the patient must for many days be fed by the rectum. It is to be feared, however, that the contact of the gastric juice may interfere with primary union, whilst there is the risk of perchance exciting interstitial inflammation in the coats of the stomach.

Biliary Fistulæ.

External or cutaneo-biliary fistulæ are the result (1) of gunshot wounds. In some cases the shot has passed right through the liver and penetrated the parietes in two places, bile afterwards issuing from one of them; in other cases the shot has been buried deeply in the liver-substance. (2) Blows over the liver lead to adhesions between that organ and the parietes, and then to abscess either in the parietes or in the liver itself. After the incision or spontaneous bursting of the abscess, a fistula results. (3) Hepatic abscess of non-traumatic origin may point and open at any part of the parietes with which the liver is in contact. These openings often heal, but in some cases a gangrenous ulceration of the parietes of the abdomen follows and keeps the fistula open. (4) Gall-stones sometimes, after leading to adhesions of the gall-passages, are discharged externally. The gall-bladder is usually the part of the biliary system thus affected. Yet after the discharge of several facetted gall-stones through the umbilicus, I have known the fistula to be only temporary; the patient was a young woman in the practice of Mr.

Morris, of Petworth, and quite recovered. Murchison[1] collected 70 cases of biliary fistula having this origin, though the situation of the external opening was not the same in all cases. The number of gall-stones discharged by the fistula has varied from one to six hundred; when there is only one, it may be as large as a hen's egg, but when there are several they are usually small and smoothly facetted by attrition. The calculi may be discharged almost as soon as the opening is formed, or not for years afterwards. (5) Distension of the gall-bladder with purulent or muco-purulent matter may lead to adhesion, and the subsequent discharge of the contents externally. A typical case of this sort is to be found in the Philosophical Transactions for August and September, 1738,[2] entitled, "An obstruction of the biliary ducts and an impostumation of the gall-bladder discharging upwards of eighteen quarts of biliary matter in twenty-five days, without any apparent defects in the animal functions." Four months before death jaundice came on, followed by pain in the right hypochondrium and an inflammatory tumor, which went on to suppuration, the abscess being opened with a lancet. On post-mortem examination, a large sac was found shut off from the general peritoneal cavity, and communicating with the gall-bladder which was itself distended.

The fistula may communicate with the liver-substance, with the gall-bladder, or with one of the larger bile-ducts: when the result of injury, it is more frequently with the liver; when the result of disease, it is commonly with the gall-bladder. The external opening may be over the fundus of the gall-bladder, to the left of the median line, in the inguinal region, in any part of the right hypochondrium, or at the umbilicus. To the umbilicus it is directed by the suspensory ligament of the liver.

Dr. Burney Yeo has recorded a case in which over one hundred gall-stones were spontaneously discharged through a fistula in the hypogastrium five inches below the umbilicus.

A case is published in the Gazette des Hôpitaux,[3] in which two biliary calculi were removed from above the clitoris, where they were encysted in the subcutaneous tissue. In one case, where the lung as well as the liver had been wounded by the same shot, the fistulous opening was below the scapula on the right side; in another case it was at the lower part of the sternum on the left side; and in a case described by Hennen, it was between the eighth and ninth ribs on the right side, two and a half inches from the spines of the vertebræ. The fistulous channel may be many inches long, and very circuitous in its course. In rare cases there are two or more openings at a distance from one another.

Symptoms.—The discharge from these fistulæ is not always pure bile. More frequently, perhaps, it is pus, or muco-pus; or these mingled more or less largely with bile or blood. The daily quantity which drains away has been found to vary from eight ounces to two pints. If the cystic duct is obstructed, no bile can flow by the fistula; if the common duct is occluded, the jaundice which precedes the fistula generally disappears after an opening is established, though even then no bile will pass off by the bowel; in rare cases the gall-ducts are patent, and bile escapes both by the fistula and with the stools. When the amount of bile lost is great, the patient rapidly loses flesh and strength, and dies marasmic. During the formation of a fistula due to gall-stone, there is often great suffering, especially whilst the calculus is passing and biliary matter is accumulating behind it; but the patient will soon recover, and may enjoy good health long before the fistula closes. Indeed, the formation of the fistula, by giving exit to calculi, may give permanent immunity from similar periodic attacks of hepatic colic and jaundice, which have occurred during a course of many years.[1] When the cause of a fistula is a wound, there will be the attending symptoms excited by the injury; when the cause is disease, there will be those attributable to it.

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[1] Lectures on Diseases of the Liver.

[2] Op. cit., vol. xl. p. 317.

[3] Loc. cit., 8 Oct., 1846.

Prognosis.—The duration of biliary fistulæ varies. In many of the cases of recovery after stabs or gunshot wounds, there has been a temporary fistula for from several days to several weeks, and then perfect closure has occurred.[2] In other cases the patients have lived for several years in more or less impaired health, with purulent and bilious matter constantly discharging from the fistula. When the cause of the fistula is gall-stone, it usually soon closes after all the calculi have come away, but it has been known to keep discharging for many months. When the calculi are numerous, and the fistula long and tortuous, the opening has continued for years—in some instances showing every now and then a tendency to close, but again and again opening to allow the escape of other calculi.

The fistulous openings are chiefly serious on account of the inconvenience they occasion. In a large proportion, when due to disease, the patients live for years in fair health; and in many instances the fistula closes altogether. Complete healing may be looked for in cases of gall-stone, if the calculus is single, if the opening is directly over the gall-bladder, if the discharge is free from bile, and if there is no jaundice. The most unfavorable cases are those in which the fistula is due to cancer, or to abscess in the parenchyma of the liver. Those cases in which the cystic duct is patent and the common duct obstructed, must result in a permanent discharge of bile, and marasmus sooner or later must ensue.

Treatment.—No general rule can be laid down for the management of these cases, except that which is common to all external fistulæ, namely, to keep the opening and the structures around it scrupulously clean and free from irritation. But little can be expected from operative attempts to close the fistula, though if the common bile-duct be patent, and the patient much debilitated by the continual loss of bile, the question of making the effort may properly be considered; but if, owing to obstruction of the common bile-duct, the bile cannot enter the bowel, there is no chance of success, and every reason for not undertaking the operation. If a calculus plug the fistula and lead to abscess, or to the accumulation of discharge; or if a calculus can be felt lodged near the orifice, it will be necessary to open up the fistula and extract, or at least facilitate the escape of, the calculus. This operation has often been successful, but it should be done with care, because there are several cases which prove that even the introduction of a probe or dressing forceps may induce fatal peritonitis. In some cases it will be right to lay open the gall-bladder and remove its contents; and there are grounds for thinking that a permanent fistula may in some cases be prevented, and in others cured, by the operation of cholecystotomy. When there remain behind one or more biliary calculi, the fistula should be kept open with the hope that they will escape through it at some future day.

INTERNAL BILIARY FISTULÆ.—Besides the external fistulæ, a variety of fistulous communications occur between the biliary passages and adjacent organs—such as the stomach, duodenum,[3] and colon, by a process of ulceration or gangrene set up by gall-stones within the gall-bladder or bile-ducts. M. Fauconneau-Dufresne[1] has collected cases of fistula between the gall-bladder and pelvis of the right kidney, vagina,[2] and portal vein.[3] Dr. Cayley[4] has reported a case in which, in consequence of the impaction of a stone in the common duct, a fistulous communication was formed through the diaphragm between the left pleural cavity and a cystic dilatation of one of the bile-ducts in the left lobe of the liver.

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[1] Lancet, March 11, 1882, p. 391.

[2] Guthrie's Commentaries, etc., 6th ed., pp. 582–584. 1855.

[3] Murchison has collected twenty-eight such cases, and in the majority of them death was caused by obstruction of the small intestine by a large biliary calculus, though in several a large calculus was passed *per anum* after the symptoms of obstruction had existed.

Murchison[5] in one instance found the gall-bladder communicating with the duodenum, the colon, and the external surface; and Bristowe[6] found the common bile-duct communicating with the colon, the duodenum, and the portal vein. Dr. Coupland met with a case in the post-mortem room at the Middlesex Hospital, in which a number of biliary calculi, varying in size from that of a millet-seed to that of a poppy-seed, were found in distinct groups outside the gall-bladder, encysted in peritoneal adhesions. The case is of interest, as showing that calculi may escape from the gall-bladder or passages into the peritoneal cavity, without necessarily exciting fatal peritonitis.[7] Cystico-colic fistula is usually associated with cancer of the gall-bladder, but it may be simple. Cystico-duodenal fistula is likely to lead to impaction of the calculus and obstruction of the bowels. The opening is generally situated in the third part of the duodenum. In cystico-gastric fistula the opening will probably be found close to the pylorus. Cruveilhier was of opinion that the fact of vomiting a gall-stone proved the existence of such a fistula. The symptoms of cystico-gastric and intestinal fistulæ due to gall-stones are usually slight and obscure; jaundice is rarely present, as the common duct is usually patent, and only occasionally is there a history of gall-stone colic with jaundice. Vomiting, with more or less colic, and tenderness in the region of the gall-bladder, are the commonest symptoms; hæmatemesis and bloody stools have been known. In cystico-urinary fistula the symptoms have been renal, not hepatic, but it must be remembered that cholesterine may be found in the urine though no such fistula exists.

URINARY FISTULÆ.

Urinary fistulæ are of many varieties, and might be classified, (1) as to the part of the urinary organs with which they communicate; (2) as to the part of the surface at which they establish an opening; (3) as to their causes; and (4) as to their characters, namely, as to whether they are simple, or callous, or attended with loss of tissue.[8] Many of the forms of urinary fistula which arise, for example, from stricture or abscess of the perineum, I am not expected to describe here; and I shall therefore confine my remarks chiefly to those which open on the surface of some part of the abdomen, merely enumerating others which consist in a communication between some part of the urinary organs and the viscera within the cavities of the abdomen and pelvis.

FISTULÆ WHICH COMMUNICATE WITH THE KIDNEY AND PELVIS OF KIDNEY.—These may be caused (*a*) by incised, punctured, or gunshot wounds, (*b*) by injury inflicted during surgical operations, and (*c*) by disease. The records of military surgery contain many examples of fistulæ caused directly by gunshot wounds of the kidney, or indirectly by the kidney becoming involved in the suppuration which follows gunshot wounds of the loins. Stabs, and incised and lacerated wounds in the back and loins, are sometimes followed immediately, or after an interval, by discharge of urine. Nephrotomy for hydronephrosis and pyonephrosis is likely to be followed by a permanent fistula, if the remnant of the kidney be not removed by nephrectomy. All traumatic renal fistulæ may be expected to close sooner or later. Abscess of the kidney, whether due to the irritation of a renal calculus or to tubercular or other form of renal disease, is a cause of urinary fistula in the loin, either by spontaneously bursting, or through the non-healing of the wound if the abscess have been opened by the surgeon. The discharge of pus and urine in such cases is often very obstinate, the wound contracting to a certain extent, and then remaining as a chronic, and sometimes even as a permanent fistula. A renal abscess may open into the colon, and has been known even to open into the stomach. In not a few cases in which the ureter has become blocked, the kidney or its pelvis, as well as the peri-renal tissue, have suppurated, an abscess has opened on the surface, and a urinary fistula has subsequently formed. McClelland, of Pittsburgh, records a case in which two fistulæ formed as the result of obstruction of the ureter by calculi: the first opened in the loin, and gave exit to a calculus, and a sinus continued; four years afterwards a second abscess formed, and was opened in the groin, giving exit to pus and urine. As the excretory function of the kidney remained, the woman's state became very offensive, and she was relieved by, and recovered from, lumbar nephrectomy. This operation has been performed no less than seven times for the relief of lumbar, abdominal, uterine, and vaginal urethral fistulæ, and in six cases with recovery.

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[1] La Bile et ses Maladies. Mém. de l'Acad. Roy. de Méd., tome xiii. p. 341. 1847.

[2] Ibid., p. 159.

[3] Ibid., p. 340.

[4] Trans. Path. Soc. Lond., vol. xvii. p. 161.

[5] Lectures on Diseases of the Liver, p. 534, Case XCIV.

[6] Trans. Path Soc. Lond., vol. ix. p. 285.

[7] See Trans. Path. Soc. Lond., vol. xxviii. p. 157.

[8] See J. A. Jagielski, De fistulis urinariis adjecta hujus morbi historia.

Treatment.—The parts around the fistulous orifice must be kept clean and free from irritation and the contact of the discharges. Time should be allowed for the spontaneous closure of the fistula, and in many instances the surgeon will not be disappointed. If, however, the fistula persist, caustics, the hot iron, or an incision—so as to lay open any sinuous track, vivify callous surfaces, or remove spongy granulations or calculous deposit—must be tried. The injection of iodine solution, besides acting as a disinfectant, will sometimes stimulate the sinus to healthy action; dilute nitric and nitro-hydrochloric acid in solution have been tried, but without any marked effect. If a foreign body, such as a bullet, piece of bone, particle of clothing, or calculus, is keeping up irritation and preventing healing, it should be removed. If the other kidney be sound, and the fistula permanent, the best treatment is nephrectomy, and this operation should be practised in any case in which, other treatment having failed, the life of the patient is threatened, or his comfort sacrificed. It should, however, be borne in mind, that persons may live long and comfortably, and even in good general health, with a lumbar fistula; and that though for a long time urine may have flowed freely from it, the quantity of urine discharged may at length be greatly reduced, or the flow may even cease altogether.

FISTULÆ WHICH COMMUNICATE WITH THE URETER.—These are generally, if not always, the result of operation wounds. Excepting those cases in which the pelvis of the kidney has been the seat of rupture, I do not know of any instance of traumatic ureteral fistula other than as a result of surgical wound. The doubtful case recorded by Mr. Holmes,[1] subsequently received from the author another interpretation, namely, that it was a wound of the theca vertebralis. After prolonged and difficult child-birth labor, urinary fistula has arisen from sloughing of, or injury to, the ureter, and the fistula in some cases has opened into the uterus, and in others into the top of the vagina. In the removal of ovarian and uterine tumors, the ureter has on several occasions been divided, and it would have been well in these accidents if the renal part had been brought out through a wound made for the purpose in the loin of the same side, and its orifice there attached by sutures so as to be outside the peritoneal cavity.

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[1] Med.-Chir. Trans., vols. lx. and lxv.

Agnew[1] mentions a case in which the ureter was accidentally divided in removing an adherent ovarian cyst. The renal end was secured in the external wound, and a urinary fistula formed. The patient lived several months, and finally died of some obstruction in the course of the duct. The great objection to bringing such a long, cord-like structure out at the anterior abdominal wound, is lest it should be a cause of subsequent intestinal obstruction. It is quite possible to mistake, for the moment, the spermatic vein for the ureter. Once in removing an ovarian tumor, in a case which was complicated by numerous and difficult adhesions, a long, narrow tube tore away from the back of the cyst-wall; it looked like the ureter, and I traced it up to the right loin; further examination, however, proved it to be the ovarian vein. It has also happened to me on one occasion, when removing the entire uterus for cancer of the os and cervix, to cut out about half an inch of the pelvic end of the ureter, which was thoroughly incorporated in the diseased tissue about the neck of the womb. I turned the lower end of the part still connected with the kidney, into the vagina, and fixed it there, and then closed the opening in the peritoneum by sutures. The patient did not, however, recover from the shock of the operation upon the uterus, so that the result of the injury to the ureter could not be determined. In six[2] out of ninety-four published cases of extirpation of the uterus, one ureter has been divided; and in two other cases, both ureters. When the disease is seated in the cervix of the uterus, and the tissues around are infiltrated, this accident is often unavoidable, unless some of the tissue infiltrated with cancer is left behind. When the disease is quite in an early stage, and situated in the os or fundus, there is little or no risk to the ureter if care be taken. I have removed the uterus for early cancer of the os uteri, by the abdomino-vaginal method, without seeing or injuring either ureter.

It was for a urinary fistula of the ureter that the kidney was first successfully removed, the operation, as is now well known, being lumbar nephrectomy; and it was performed by Simon, of Heidelberg. Out of eight nephrectomies for urinary fistula, seven have been lumbar and one abdominal; the abdominal incision was made more externally or laterally than the linea semilunaris, and the operation was performed by Mr. K. Thornton. The cases in which large urinary cysts have formed and been tapped in the lumbar region, and which have been supposed to be due to wounds of the ureter,[3] have been discussed in a previous section of this article. (See Wounds of Kidney and Ureter.)

FISTULÆ WHICH COMMUNICATE WITH THE URINARY BLADDER.—(1) *Vesico-abdominal Fistulæ.*—Wounds, gunshot and otherwise; sub-parietal rupture of the bladder; ulceration of the coats of the bladder from disease of its walls or from the pressure of a foreign body within the organ; and inflammation beginning in the peritoneum, pelvic cellular tissue, or ovary or other pelvic organ, are all causes of vesico-abdominal fistula, that is, of fistula opening externally upon some part of the abdominal wall, and communicating with the bladder.

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[1] Principles and Practice of Surgery, vol. i. p. 376.

[2] Spencer Wells, Med.-Chir. Trans., vol. lxv. p. 34.

[3] Stanley, ibid., vol. xxvii.

(*a*) Dr. Otis[1] gives records of a number of very satisfactory recoveries after shot-wounds of the bladder. In several of them the missile traversed the distended bladder obliquely, passing in at the right or left side of the hypogastrium and out at the opposite buttock; in some instances the ball entered above the pubis; in one it passed in at the iliac fossa and perforated the fundus of the bladder on its way out at the opposite buttock. In some of these cases the wounds healed very rapidly, urine escaping from one or both orifices, but generally from the supra-pubic, for a short time, and the wound then closing without ultimate derangement of the function of the bladder. In others a troublesome urinary fistula remained for two or three years, and then permanently closed. In some cases the patients recovered, but with persistent urinary fistulæ, the persistence of which was in several instances due to the presence of dead bone, though in others there was neither the presence of dead bone nor any other foreign source of irritation. Other patients are reported as recovering from recto-vesical fistulæ from gunshot wounds, early in some cases, but in others the fistula remaining pervious for long periods. The learned historian of the War of the Rebellion remarks: "It is rare to find the functions of the bladder perfectly restored after shot injury."

(*b*) Stricture of the urethra may lead to ulceration of the parietes of the bladder, and this to an external fistula. Sir Benj. Brodie mentions that, in cases of old and neglected stricture, abscesses may form above the pubis, owing to vesical ulceration; and he adds that the surgeon may be deceived into fancying that the supra-pubic tumour is a distended bladder.

(*c*) Sir Prescott Hewett has described[2] a case of urinary abdominal fistula after rupture of the bladder. A man aged fifty-three suffered rupture of the bladder behind the pubis, and by the twelfth day afterwards three distinct tumors had formed in the lower part of the front of the belly. An incision was made into one in the left iliac region, and about three pints of fetid pus with large sloughs were let out. Urine afterwards passed through this opening. The man died on the twenty-third day.

(*d*) A foreign body may find its way from the bladder by ulceration, and lead to a fistula in the groin. An interesting case is mentioned by Sir Hans Sloane in his reply to the Marquis de Caumont, who had sent Sir Hans "a very remarkable stone taken out of a man's bladder after death." Sir Hans writes[3] "I have likewise a common pin which by some means or other had got into the bladder of a young woman, and was there coated all over by a calculous matter; but having occasioned a fistulous ulcer in her groin, it was discharged thence with the matter of the fistula."

(*e*) In other cases a foreign body may ulcerate into the bladder, and likewise through the abdominal parietes, and thus give rise to a vesical urinary fistula. A very remarkable case was related by M. Hippolyte Larrey, before the Académie de Médecine, of a dermoid cyst of the ovary complicated by a urinary fistula in the median line of the abdomen, half way between the pubis and the umbilicus. It occurred in a previously quite healthy woman, aged 33, who had borne three children, and had had rapid recoveries after her confinements. Some days after the third, however, she felt a severe pain with heat and swelling in the left iliac region, and pus was passed with the urine. For five years all symptoms subsided; then the tumor increased, and spontaneously opened below the umbilicus, and a quantity of hair and pus was discharged. Afterwards, urine in large quantities passed by this abdominal opening. Some of the hair from the cyst likewise escaped into the bladder, through a fistulous communication, and there, phosphatic matter being deposited upon the hair, so considerable a calculus was formed as to entirely prevent any urine flowing off by the urethra, so that at length the whole of it was passed through the fistula. The patient was cured by a single operation, which consisted in introducing a bistoury at the abdominal fistula, and laying open the cyst by cutting the abdominal parietes downwards along the median line; then with a sound in the bladder and the finger in the lower part of the cyst, the fistulous communication between the cyst and the bladder was found, and enlarged, and the calculus was removed through the incisions thus made.

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[1] Medical and Surgical History of the War of the Rebellion, Part II. Surgical Vol., p. 264.

[2] Trans. Path. Soc. Lond., vol. ii. p. 228.

[3] Philos. Trans., vol xl. p. 375. 1737–1738.

(*f*) Inflammation of the peritoneum, or of some one of the pelvic viscera, may lead to adhesion and ulceration of the bladder, and then to a circumscribed abscess, which, bursting through the abdominal wall, results in an urinary fistula indirectly communicating with the bladder.

(*g*) Similarly, inflammation of the sub-peritoneal cellular tissue may lead to suppuration around and ulceration into the bladder; and by the burrowing of pus an external opening may be formed on the abdomen, above the pubes, at the groins, by the side of the anus or in the adjacent parts of the nates, or over one of the large foramina of the pelvis, a complete urinary fistula being thereby established.

(2) *Vesico-visceral Fistulæ.*—Urinary fistulæ are not unfrequently established between the bladder and rectum, bladder and vagina, or bladder and small intestine, as the result of inflammatory adhesions and ulceration between those parts. When the small intestine becomes matted together, and adherent to a sloughing or ulcerating bladder, a firm tumor may be formed in the hypogastrium, and be mistaken for a distended bladder. I have elsewhere reported a case somewhat in point.[1]

Simple chronic inflammation, tubercle, cancer of the bowel, uterus, or vagina, and cystic and other diseases of the ovary, are common causes of these forms of urinary fistula. Stricture of the urethra, calculus, or indeed any cause within the bladder which excites adhesion to parts around and ulceration of the bladder-walls, will conduce to them.

URETHRAL FISTULÆ OPENING EXTERNALLY THROUGH THE WALLS OF THE ABDOMEN.—In extravasation of urine from stricture of, or injury to, the urethra, and also occasionally after lithotomy, the urine may find its way behind the triangular ligament into the pelvic cellular tissue, when, unless death quickly takes place, suppuration is excited, and matter may point above Poupart's ligament on one side or the other. Thus an urinary fistula is formed. I have seen this happen after lateral lithotomy; the pus burrowed up through the pelvis, and along the spermatic cord, and was let out below the external abdominal ring. The patient, a man aged fifty-six, died fourteen days after the lithotomy from a large abscess in the liver.

When the urine, after extravasation in front of the triangular ligament, finds its way beneath the skin of the abdomen, it may travel as high as the umbilicus, and a fistula may form in the groin, or elsewhere upon the front or side of the abdomen.

In these cases as in those of deeper-seated extravasation, suppuration is generally very free, but the fistulous opening will soon emit urine if the patient lives through the period of suppuration. Wilmot[2] relates a case of extravasation of urine from a ruptured urethra complicated with fracture of the left ramus of the pubis. Perineal fistulæ formed, and others opened in the thighs, right groin, and above the pubes. All of them discharged urine, nearly the whole of which fluid escaped by the fistulæ for more than a year, and until Mr. Cusack, under whose care the patient was, re-established the normal urethra by dividing a fold of false membrane which had been obstructing the canal opposite to the seat of fracture. Sir Benjamin Brodie found, after death, "a large abscess in front of the pubis, extending half way towards the navel; another among the adductor muscles of the left thigh; and a third among the muscles of the upper part of the right thigh, as far outwards as the foramen ovale of the ischium, the periosteum having been destroyed and the bone itself rendered carious; and all these abscesses could be traced into an abscess in the perineum, communicating with the urethra, behind a stricture, by a small orifice." In an interesting inaugural dissertation on Urinary Fistulæ, by J. Antonius Jagielski, a case is related of a farm laborer, who, in June, 1819, was gored by a bull, the horn of which passed through the middle of the right thigh, towards the perineum and scrotum, blood trickling from the urethra; a stricture of the urethra followed, and immense urinary fistulæ resulted, and opened in the upper part of the thigh on its inner and posterior aspects, in the scrotum, and in the ischial regions; urine had also burrowed amid the cellular tissue of the pelvis and led to a large stinking abscess, as well as to contraction of the tissue around the rectum, and such great destruction of it as to expose the three inferior sacral nerves.

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[1] Medical Times and Gazette, July 28, 1883, p. 92.

[2] Stricture of the Urethra, p. 179.

Matter pent up behind the deep perineal fascia is likely to burrow in the pelvic cellular tissue, and, dissecting its way by the side of the bladder, to open into the vagina, rectum, or some other part of the bowel; and thus to establish a complete uretero-rectal, or uretero-vaginal, or vesico-rectal, or vesico-vaginal fistula.

Treatment.—No general rules can be laid down, for enough has been said to show that the cause of the fistula must be ascertained, and the treatment directed accordingly. One thing will always be requisite, viz., to establish a free, and, if possible, natural channel for the proper escape of urine. Thus if stricture exists, it must be treated; if a foreign body is in the bladder, it must be taken away. All causes of inflammation around the bladder must be removed, and if extravasation have occurred, the prompt surgical treatment demanded for that emergency, and for the cause which has given rise to it, must be at once brought into effect.

In most cases the condition is very pitiable, and a cure is consequently demanded. Every act of micturition is attended with the escape of urine through the fistulous channel. When this channel is wide and direct, precaution can be taken to keep the clothes dry and clean; but when it is oblique or tortuous, the urine dribbles away long after the act of micturition is over, there is an ammoniacal odor always present, the clothes cannot be kept dry nor the skin free from excoriation, and the state of the patient is one of loathing and disgust. If, under these circumstances, relief is not obtained, the health of the patient fails gradually, and death ensues.

URACHAL ABSCESS AND FISTULA.

Most writers on the development of the bladder have referred to the occasional patency of the urachus at the time of and after birth, and to the discharge of urine from its umbilical extremity, which, under that condition, is likely to take place. Very frequently, perhaps generally, the urachus at birth is tubular for a short distance above the bladder,[1] but in after life it becomes a mere fibro-muscular cord. The urachus retains the tubular character of the allantois till about the thirtieth week of fœtal life, but the exact time at which the metamorphosis of the allantois is complete, varies in different animals, and in different instances in the human subject. At birth, according to some observers, the urachus very frequently does not extend as far as the navel, but about five or six centimetres from the bladder passes into a number of tendinous threads, which unite with the right and left lateral ligaments of that organ. Luschka,[2] who holds this view, says, however, that in very many cases a tubular elongation of the mucous membrane of the bladder may be found, the commencement of which is indicated by a minute opening passing from the cavity of the bladder; but that generally, in place of this opening, a depression is to be seen, though even this is often absent, and all trace of tubular communication lost. Rokitansky[3] says, "The urachus may remain patent to a certain distance from the bladder, or throughout its entire extent." Cruveilhier,[4] following Boyer, states that in urachal fistula the urethra is always obliterated; and Boyer goes on to remark that the fistula ceases to exist as soon as the obstruction at the neck of the bladder is removed, so that the urine can flow by the urethra.[5] That these distinguished anatomists were wrong in this opinion, there can be no doubt, if the case of Mr. Thomas Paget, of Leicester (which will be again referred to), and one reported in the Medicinische Zeitung,[6] of Berlin, as well as a few others on record, are admitted to be urachal fistulæ. Boyer[7] is further of opinion that in the great number of cases in which there is a discharge of urine from the umbilicus of young persons and adults, the fistulæ have not been caused by the dilatation of an unobliterated urachus; but that the real cause has been, *first*, an obstruction to the passage of urine by the urethra, and, *secondly*, to a herniary protrusion of the mucous membrane of the bladder through the rest of its coats, near the point of connection of the urachal ligament; and that this herniary protrusion has extended as far as the umbilicus, and has subsequently ruptured. He, however, records no case in support of his hypothesis, but the perusal of Mr. Paget's case makes me incline to think that there may be instances of the kind which Boyer supposes. In Mr. Paget's[8] patient, the umbilical orifice of the fistula measured three inches by two inches; through it a hernial protrusion, the size of a goose's egg, had occurred, and along this the surgeon's fingers could be passed right into the bladder. Though the man had no difficulty in voiding urine, and though a catheter could easily be passed when he was under Mr. Paget's care, it is quite possible that some obstruction had existed in early life before the fistula had formed. I have made a dissection in one case, and reported another,[9] in which saccular dilatation of the kidneys, ureters, and bladder occurred in a fœtus, and in which the only cause of obstruction found on examination was a thin membranous septum, easily broken down with a small catheter, in the membranous part of the urethra. A less complete septum might, perhaps, give rise to the umbilico-vesical hernia described by Boyer, and from the ease with which it yields to an instrument passed along the urethra, such a septum might not be suspected to have existed.

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[1] See a thesis by Johannes Noreen, entitled "De mutatione luminum in vasis hominis nascentis in specie de uracho," in the fifth volume of Haller's Disputationes Anatomicæ Selectæ, pp. 713 *et seq.*

[2] Luschka, Brit. and For. Med.-Chir. Review, 1862.

[3] Manual of Pathological Anatomy, Syd. Soc. Transl., vol. ii. p. 219.

[4] Library of Medicine, ed. by Tweedie, vol. vii. p. 592.

[5] Traité d'anatomie. Splanchnologie, p. 477.

[6] Med. Zeitung, No. 19. 1837.

[7] Op. cit., p. 479.

[8] Med.-Chir. Trans., vol. xxxiii. p. 293. Mr. Paget's case is entitled "A case in which the urachus remained open, and a ring-shaped calculus, formed upon a hair in the bladder, was extracted through the umbilicus."

[9] Congenital Hydronephrosis, with remarks on the Secretion and Excretion of Urine in the Fœtus. Proceedings of the Royal Medico-Chirurgical Society of Londox, 1876; and Lancet and Brit. Med. Journal, May 13, 1876.

Agnew[1] has briefly mentioned a case seen by him, which, in the absence of proof to the contrary, is capable of being explained on Boyer's theory; it was that of a child, who had no fistulous opening at the umbilicus; but when urine was allowed to accumulate in the bladder, the navel became distended.

The kind of orifice is not the same in all urachal fistulæ:—

1. In some, a peculiar, button-like, papillary or columnar projection at the umbilicus, having an orifice at its summit, has been described. Mr. Bryant[2] mentions a case in which the projecting mass was about the size of, and not unlike, the glans penis. The orifice was constantly moist, but especially so when the bladder was distended. The boy was eight years old, and the condition was congenital. It was regarded as a case of open urachus. Mr. T. Smith[3] gives a brief note of a case very similar to Mr. Bryant's. The boy was two years old, and had a button-like protrusion at the umbilicus, which was constantly moist, and the discharge, though slight, had the odor of urine.

2. The urine may escape at several points on the surface of a hernial protrusion, as in the case described in the Medicinische Zeitung. An infant aged four weeks had a urachal fistula discharging urine copiously through several points on the excoriated surface of a hernial swelling which projected three-quarters of an inch. The excoriated area was one-quarter of an inch long and one line broad. The urine was normally discharged by the urethra.

3. The orifice may be a mere deficiency—circular, oval, or irregular—in the linea alba. In the adult male patient under the care of Mr. Paget, of Leicester, it was circular, with a thick margin of cartilaginous hardness.

4. It may be situated in the cup-like depression of the navel, or hidden from view by the falling together of the skin of the umbilicus. In a second case described by Mr. Paget,[4] that of a female child aged four months, the orifice was thus hidden from view, but on drawing aside the folds of skin, urine always escaped; the lining membrane of the tube was cuticular for a short distance, and then became mucous membrane; the orifice was large enough to receive an ordinary cedar pencil.

5. There may be, as already mentioned, a hernial protrusion at the umbilicus; the external covering of such a hernia instead of being skin is mucous membrane, which, however, becomes pale and dry after prolonged exposure. In these cases the fistulous orifice is at the side or on the summit of the hernia. In some cases the hernial protrusion acts like a plug to prevent the continual escape of urine, but is withdrawn during the act of micturition by the pull of the vesical muscular fibres, and thereupon urine is ejected at the fistula as well as along the urethra. This was the condition in Mr. Paget's adult patient; the first contraction of the bladder had no other effect than to draw into the abdomen the whole of the protruding parts, and until this was accomplished no urine passed by the urethra. The jet of urine from the umbilicus which then followed, was sudden, and ceased, not to be renewed except by a violent accelerating action of the expulsor muscles. The bladder would retain a pint of urine without any escaping, and it seems to me that this case sheds some light on several points connected with vesical rupture.

6. The fistula may be indirect. It will probably be so when an abscess

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[1] Agnew's Surgery, vol. i. p. 388.

[2] Med. Times and Gazette, vol. i. p. 456. 1862.

[3] Ibid., vol. i. p. 320. 1863.

[4] Med.-Chir. Trans., vol. xliv. p. 13.

precedes it, as in the case reported by Mr. Savory.[1] This patient was a male child, aged thirteen months, in whom an abscess, which had been forming for eight weeks, pointed, and was opened at the umbilicus. The symptoms were pain in the lower part of the abdomen, and frequent desire to micturate. Vesical calculus was suspected. Afterwards there was a discharge of pus, and of nearly all the urine, through the umbilical fistula. The child died nine days after the abscess was opened. At the autopsy it was discovered that a polypus of the bladder had led to obstruction at the orifice of the urethra, and this to dilatation and suppuration of the ureters and kidneys. A small papilla on the upper part of the vesical wall represented the unobliterated urachus, but a probe could not be passed from the urachus into the bladder. Mr. Savory surmised that a valvular communication with the bladder had existed, and that the urine, having been propelled into the urachus, had set up suppuration around, so that by degrees the urachus had been destroyed, and an abscess cavity formed between the peritoneum and the rest of the abdominal parietes. The abscess extended in the course of the urachus from the bladder to the umbilicus. Though no opening could be detected after death between the bladder and abscess, or urachus and abscess, there is the fact that during life, for some days, nearly all the urine passed through the umbilical fistula, and the fair inference is that the urachus communicated with the abscess cavity.

Urachal fistulæ may be either congenital or non-congenital. When an abscess precedes the fistula, as in the case just referred to, the latter is non-congenital; and in some cases where there has not been an abscess, the fistula is not congenital, though in all, the defect which makes it a possibility and which indeed predisposes to it—namely the non-obliteration of the urachal tube—is of course congenital. Dr. Francis Cadell[2] has reported the case of a girl aged eight, who from earliest infancy had had difficulty in micturition with frequent desire to pass water. From four years of age the symptoms of cystitis had increased, and when eight years old, after a few days of great pain, with swelling and hardness of the belly, urine was observed to come in a small stream from the navel. A No. 6 catheter could be passed through the fistula into the bladder. The child died four months afterwards from cystitis, with sacculated and suppurating ureters and kidneys. At the autopsy the umbilicus was found to be natural, save for the fistulous opening, which presented neither fungating granulations nor induration about its margins. The bladder was contracted and thickened, and the little finger could be passed from it into the unobliterated urachus, which gradually narrowed towards the navel. In this case the urachus must have been in part patent from birth, and have become gradually dilated until it gave way altogether, when a urinary fistula was established.

Mode of Origin of Non-congenital Fistula.—When the lower end of the urachus remains open, some of the urine is forced into it in each act of micturition, especially straining micturition, and at the commencement of the act, as was shown by Paget's case. If the bladder becomes after a time the seat of inflammation, the difficulty and straining in micturition will increase the dilatation of the urachus, as it does that of the ureters and pelves of the kidneys. Again, if, as Luschka seems to indicate, the vesical orifice of the urachus becomes very minute, or even closes, we see how the tube of the urachus may be converted into a shut sac; and then, if any urine or mucus is inclosed within it, inflammation and abscess will be caused, and the abscess may either burst spontaneously, or be opened by the surgeon, at the umbilicus, where it points. In either of these ways a non-congenital fistula may be formed, quite independently, as it would seem, of any mechanical obstruction at the neck of the bladder or in the urethra.

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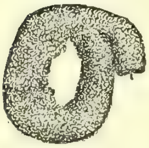
[1] Med. Times and Gazette, vol. ii. p. 106. 1852.

[2] Umbilical Urinary Fistula. Edin. Med. Journal, September, 1878, p. 221.

In Dr. Cadell's case, the fistula was direct, complete, and unassociated with abscess; but non-congenital, and urinary. When an abscess occurs after the obliteration of the vesical end of the urachus, and opens at the umbilicus, the resulting fistula is non-congenital, and may or may not be complete or urinary, according as there is or is not a communication between the abscess and the bladder.

Complications of Urachal Fistula.—Some of the complications are also in part causes, others are results, and others again merely coincident. Of the first set, there are polypus of the bladder, urethral calculus, phimosis, congenital stricture, and everything which prevents the free discharge of urine by the natural passage. That these, though efficient, are only in part causes, is clear; as there must be also an imperfect closure of the urachus to permit of a true urachal fistula. When this patency does not exist, the bladder, ureters, and kidneys may all become sacculated, but without any tendency being shown to dilatation or re-opening of the urachus. This is proved by cases of congenital hydro-nephrosis. A remarkable complication or result of fistula was witnessed in Paget's adult patient: a ring calculus (Fig. 1114) was formed by the deposit of uric acid on a small hair from the pubes, which had found its way into the bladder through the umbilical opening. Cruveilhier[1] also met with a calculous concretion within the urachus, and he goes on to remark that Huller and Harder have made similar observations. Boyer[2] says that in 1787 he dissected the bladder of a man aged 26, whose urachus formed a canal an inch and a half long, and contained twelve urinary calculi as large as millet-seeds, one being larger and resembling a grain of barley. Though a fistula did not exist in this case, there was here a very sufficient exciting cause of abscess or ulceration, which might easily have resulted in a fistula. Luschka[3] has suggested that the cells of the lining mucous membrane of the urachus may occasionally be developed into cysts and need surgical interference; he does not, however, record any case of the sort.

Fig. 1114.



Ring calculus extracted through a urachal fistula. (T. Paget.)

Prognosis.—When the fistula is congenital, and caused by some obstruction to the outflow of the urine, the prognosis is unfavorable, as death from renal disease is likely to result, unless the source of the obstruction be removable, like phimosis or urethral calculus. When the fistula is non-congenital, and follows cystitis or abscess, the health of the patient will have been greatly destroyed, in all probability, before the fistula is established, and death will occur subsequently from exhaustion, cystitis, or pyelo-nephritis. In cases of simple patency of the urachus, without urinary obstruction, there is no reason why life should be interfered with, though the comfort of the individual necessarily is so.

Treatment.—There are two clear indications, namely: (1) to remove any source of obstruction to the natural discharge of urine, and (2) to close the fistula when there is nothing (like cystitis, or obstruction) to require it to be kept open. When phimosis exists circumcision should be performed, as in a case recorded by Dr. J. J. Charles,[4] of Belfast. When a calculus is present it must of course be removed. If cystitis exists, dilatation of the urethra in the female, and median external urethrotomy in the male, will assist in relieving the cystitis, if it does not effect a cure of the fistula.

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[1] Op. cit., p. 592.

[2] Op. cit., p. 477.

[3] Virchow's Archiv, Band xxiii. Heft. 1 und 2, S. 1.

[4] British Med. Journal, October 16, 1875.

With a view of closing the umbilical orifice of the fistula, different methods have been tried, and each may succeed, though all may fail. If the opening is a vent for pus, or for urine which cannot, or can only with difficulty, pass through the urethra, no attempt at closure ought to be made. When the opening is upon a papillary outgrowth, it is sometimes sufficient to apply a ligature around the base of the papilla, which in a few days will then dry up and fall off, and the fistula will be permanently closed. In other cases nitric acid, or the actual or Paquelin's cautery, may be applied to freshen the edges of the orifice, with the view of starting healthy granulations. In other cases, again, the plan of dissecting off the skin around the opening and bringing the raw surfaces together with hare-lip pins, as was so successfully done by Mr. Paget in his two cases, should certainly be tried. In Mr. Paget's first case, the operation was performed when the patient was fifty-five years of age.

FECAL FISTULÆ.

Fecal fistula differs from so-called "artificial anus" in having much smaller external and internal orifices, and consequently in not allowing of the discharge of more than a small portion of the intestinal contents through them, instead of the whole, or nearly the whole, as is the case in the other affection. Moreover, a fecal fistula, though sometimes very short and direct, has generally, as its name implies, a narrow track or channel between its intestinal and outer orifices, and sometimes this track is long and sinuous; whereas, in artificial anus the internal orifice, which involves a great part, if not the whole of the lumen of the bowel, is adherent to the parietal peritoneum, so as to be nearly, or perhaps exactly, opposite the opening in the skin. Again, whereas an "artificial anus" always opens upon the cutaneous surface, some fecal fistulæ open internally into other viscera, for example, the vagina, urinary bladder, gall-bladder, stomach, or some other part of the bowel. Fecal fistulæ, too, are sometimes "blind:" that is, the fecal matter which escapes from the intestinal orifice burrows in the retro-peritoneal cellular tissue, or passes into an abscess-cavity, instead of being discharged through a second opening; these cases, however, are considered under the headings of fecal extravasation and fecal abscess, and need not be further referred to here.

There is a form of fistula, intermediate between the complete and the blind, in which the intestine communicates with an abscess, and the abscess with the surface; as in Dr. Coupland's case, for instance, mentioned under the heading of retro-peritoneal extravasation (p. 949), in which both the stomach and descending colon communicated with an abscess in the left hypochondriac and lumbar regions, from which pus and fecal matter escaped through an opening in the loin.

Fecal fistulæ may communicate with any part of either small or large bowel; sometimes there is more than one opening in the bowel, as there frequently is more than one on the surface. I have seen three or four perforated ulcers in the cæcum, opening into the same fistulous track; and I have had for the last eighteen months under my care, a child with a fecal fistula following the bursting of an abscess and communicating with the transverse colon, in whom there were, when first seen by me, two external openings in the linea alba, and in whom a third formed, shortly afterwards, on one side of the other two; all the fistulous tracks communicated in the substance of the abdominal wall beneath the reddened and undermined skin. Velpeau mentions a case in which there were five or six distinct external apertures, and Dupuytren refers to a somewhat similar instance. Gross,[1] in speaking of the external orifice of "artificial anus," says, that instead of a single opening there are occasionally several, which communicate with the main outlet and sometimes with each other, and he continues, "this perforated and cribriform state of the parts is generally produced by some of the stercoraceous matter insinuating itself amongst the muscular fibres and cellular substance of the abdomen, before the margins of the external orifice are sufficiently protected by the new adhesions. An abscess soon forms, preceded by an erysipelatous blush of the skin, and followed by a discharge of purulent matter, almost insupportably fetid in its character." This account exactly describes what occurred in a case of fecal fistula under my own care, in which the greater part of the fecal matter was passed by the anus.

Causes of Fecal Fistula.—Fecal fistulæ are either congenital, and due to defects of development; or non-congenital, and the effect of pathological causes.

Congenital fecal fistula is occasionally due to the persistence of the omphalo-mesenteric duct. This constitutes a rare form of umbilical fistula, attended with a fecal or biliary discharge. Cooper Forster[2] mentions two such cases, and Holmes[3] alludes to two others, in one of which the fluid which escaped was pure bile, in the other a mixture of bile with the ordinary intestinal contents and ingesta. Prof. Marshall has reported the case[4] of a male child, with a projecting tumor of the umbilicus, the size of a hazel-nut, of a florid-red color, and perforated at its apex by an orifice from which there was a constant mucous discharge. This opening led into a long canal, into which a probe passed backwards and to one side, and not downwards towards the bladder; nor had urine ever passed by the umbilicus. The direction of the canal, and the statement that fluid, in color and smell like the contents of the bowel, had occasionally exuded from the external orifice, led Mr. Marshall to diagnose the case as one of that rare condition—namely, persistence of the early connection between the umbilical vesicle and the intestine of the embryo; the red protrusion being the enlarged stump of the umbilical cord. The external orifice was successfully closed by dissecting away the mucous membrane and bringing the raw edges together; but, as Mr. Marshall pointed out, there would always be a risk that fecal matter might accumulate in this (then closed) duct, and set up inflammation and suppuration.

In cases of abscess in the anterior wall of the abdomen, followed by discharge of such substances as cherry-stones, or other foreign or fecal matter, there is often an intestinal diverticulum formed, according to Meckel, by a persistence of the vitelline duct.

Another group of congenital fistulæ is formed by those associated with *imperforate anus.* These may open externally in the raphe, near the scrotum or near the posterior commissure of the labia, or on some other part of the perineum; or in the loin, as in a case seen by Larrey, in which the opening was three inches from the spine. I have a note of a case in which the rectum of a new-born child opened in the linea alba, between the umbilicus and symphysis pubis; and other cases are on record in which the fistulous opening has been in the linea alba, or in some other part of the front wall of the abdomen. In other cases the fistula opens internally, into the vagina, or in the male into the bladder or urethra. When the rectum opens into the vagina, the amount of suffering and inconvenience is sometimes remarkably slight. I operated, in 1871, upon a child five months old, with a fistulous opening into the vagina, about the size of a crow's quill, or less; there was a mere dimple in the situation of the natural anus. An incision was made through this dimpled area, and a curved probe was passed in at the vaginal orifice, and felt for with the finger in the wound; it was then cut upon, and the edges of the incision in the bowel were stitched to the margins of the skin-wound; the new orifice was kept dilated with a small bougie; the vaginal fistula soon closed; and twelve months afterwards the mother described her child's condition as "just like that of any other healthy child of the same age." The little girl was alive, and in all respects quite well, in September, 1883.

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[1] Experimental and Critical Inquiry into the Nature and Treatment of Wounds of the Intestines, p. 177.

[2] Surgical Diseases of Children, London, 1860.

[3] Principles and Practice of Surgery, 3d ed.

[4] Med. Times and Gaz., Dec. 5, 1868, p. 640.

When the opening is into the bladder or male urethra, the suffering and inconvenience are generally great; the fecal matter gives rise to the symptoms and conditions of stone in the bladder, and life is jeopardized unless an artificial anus is made higher up in the bowel.

The small size of the orifices, the slow escape of the fecal matter, and the difficulty with which it often passes from the bowel through the opening, make these cases much more of the nature of fecal fistula than of the nature of "artificial anus."

Non-congenital or Pathological Fistulæ.—(1) *External injury* may lead to fecal fistula in either of the following ways: (*a*) Both the abdominal parietes and the intestine may be perforated, and if the gut remain *in situ* opposite the external wound, adhesion taking place between the wounded gut and parietes, a fistula may follow without any extravasation into the peritoneum. An artificial anus is sometimes formed in this manner, but whether the fecal opening will be a fistula or an anus, depends on the size of the wound; an artificial anus may in a short time be converted by the healing process into a mere fistulous opening. (*b*) Enterorrhaphy may be performed, that is, the gut may be stitched and returned to the abdomen; but complete union not following, a fistula may result. (*c*) If the wounded gut be stitched to the external wound after the manner of Scarpa, Palfyn, or John Bell, either a fistula or artificial anus may result. Here again it may be at first an "artificial anus" and subsequently a fistula, which in turn may permanently close. (*d*) A blow may cause contusion of the bowel without actual perforation, and yet a fecal fistula may result from the subsequent sloughing of the contused gut. (*e*) Contusion of the parietes may lead to abscess, and this to adhesion, and then to ulceration of the bowel, and thus to fistula. (*f*) Shot-wounds of the small intestine nearly always prove fatal, but recovery with fecal fistula has occurred in some few instances. Guthrie[1] gives a case of recovery after musket-ball wound; the ball entered the right iliac region and came out a little below the umbilicus on the opposite side; "a fecal bilious discharge, evidently from the small intestine, took place." John Thomson[2] mentions a case of shot-wound in which the place of entrance was three inches above the posterior spinous process of the left ilium, and that of exit at the right hypochondrium near its middle. For fifteen days a part of the food taken came out at the posterior orifice, through which two lumbrici were also discharged. No vomiting occurred throughout the case, and recovery ensued.

Besides these two cases, Otis[3] was only able to collect six instances of recovery from shot-wound of the small intestine, in either ancient or modern warfare, with one other case besides, in which it was doubtful where the intestinal opening was situated, though Otis inclined to the belief that the fecal fistula followed sloughing of the cæcum. The fistula in each of these cases appears soon to have closed.

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[1] Wounds and Injuries of the Abdomen, p. 35.

[2] Report of Observations made in the British Military Hospitals in Belgium, etc., p. 105.

[3] Medical and Surgical History of the War of the Rebellion, Part II. Surg. Vol., p. 74.

In civil life, recovery with temporary fistula has followed enterorrhaphy in a gunshot wound of the small intestine;[1] but Otis tells us that it has not done so in military surgical practice. Larrey, however, treated a soldier who was wounded at the siege of Cairo (1799), by stitching the completely divided ileum to the edges of the external wound, with good result. After two months, the ends of the divided bowel were connected together by adhesions, and were almost in contact. The artificial anus contracted to a fistula, which was dressed and covered with Desault's tampon, at intervals, for another two months, and the patient left the hospital perfectly cured.[2]

Wounds of the large intestine, whether incised, lacerated, or gunshot, are much more frequently followed by recovery with a temporary or permanent fecal fistula. Otis states that patients with shot-wounds of the transverse colon have rarely survived, but that many survivals have been seen after perforations of the cæcum and ascending colon, and still more after wounds of the sigmoid flexure and descending colon. He goes on to say "not a few of these fortunate cases were complicated by groovings or perforations of the wings of the innominata. Nearly all were attended with stercoral fistulæ, which commonly closed after a time without operative interference, re-opening at intervals and then healing permanently."[3] He gives one case of recovery after shot-wound of the transverse colon; the ball entered on the left side at the junction of the tenth rib with its costal cartilage, passed backwards and slightly downwards through the abdomen, and came out behind and a little to the left of the second lumbar vertebra; small pieces of paper and clothing which had been driven in before the ball, escaped by the stomach and by the anus for three weeks; and for a long period on attempting to evacuate the bowels, feces and urine, and seeds of fruit eaten, passed by both wounds; a small piece of bone, too, was removed from each. Out of 59 cases of shot-wound of the large intestine during the War of the Rebellion, the stercoral fistula persisted in 9, and closed in 50—within a month in 17, within a year in 28, and in 5 at periods extending from one year to four.[4] Teale's[5] tables show the same favorable results.

(2) Probably the most frequent cause of fecal fistula in civil life is sloughing after *strangulated hernia*. If a small hole forms from ulceration or sloughing in the strangulated bowel after its reduction, a fistula, or an abscess followed by a fistula, will result, provided that adhesions have sealed the general peritoneal cavity against the risk of fecal effusion. Artificial anus follows when sloughing of a large part of the strangulated bowel occurs.

(3) *Abscess* may arise from other causes than external injury, and result in fecal fistula. Teale[6] has collected four typical cases, Jobert[7] gives others, and still others are given under the heading of fecal abscess in this article.

(4) Mr. Bryant[8] has reported a remarkable case of fecal fistula which formed spontaneously at the lower end of an *ovariotomy wound*, on the fourteenth day after an operation for a semi-solid tumor of the left ovary complicated with ascites. The pedicle was secured in two parts by a strong whipcord ligature, and dropped back into the abdomen. After the free discharge of feces for four days, the fistula closed for seven days, and then opened again

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[1] Gissing's case, Brit. Medical Journal, 1858. (A boy aged 17, injured by the bursting of an iron cannon.)

[2] Mém. de Chir. Mil. et Camp., t. ii. p. 160.

[3] Op. cit., Part. II. Surg. Vol., pp. 76, 77.

[4] Otis, op. cit., p. 98.

[5] Teale, Art. "Intestinal Fistula," in Costello's Cyclopedia of Practical Surgery, vol. ii.

[6] Ibid., p. 361.

[7] Maladies du Canal Intestinal, tome ii. 1829.

[8] Guy's Hosp. Reports, 3d series, vol. xiv. p. 228.

and discharged, besides feces, the double loop of ligature with which the pedicle had been secured. In three days from this time the wound had healed, and in three weeks more the patient had left the hospital well.

(5) Any disease of the bowel which causes *ulceration or sloughing* may lead to fecal fistula. Thus simple, syphilitic, and cancerous strictures, and other causes of intestinal obstruction, frequently give rise to internal or external fecal fistula, fecal abscess, or fecal extravasation. Mr. Garlick,[1] of Marlborough, reported the case of a gentleman aged sixty-five, who suffered from cancerous stricture of the sigmoid flexure, and who for six weeks before his death passed no feces but what came away with his urine. At the post-mortem examination, a communication (more of the character of an artificial anus, however, than of a fistula) was found to exist between the colon and the fundus of the bladder; both colon and bladder at this part were much thickened, and the diameter of the colon, particularly the part of it which terminated in the rectum, was much contracted; this contraction was supposed to be the reason why no feces had been discharged *per anum.* I have performed colotomy upon an old gentleman with much the same condition, nearly all the feces being voided through the bladder and urethra. The relief afforded by colotomy in such cases is so great that it is simply cruel to deprive the patient of its benefit; nay more, it is bad practice to allow the disease ever to reach this stage without previously performing the operation. Entero-vaginal, recto-vaginal, gastro-colic, gastro-iliac, cæcal, and other fistulæ are formed in this way. Scarcely a fortnight passes without one or other of these forms of fistula, the result of cancer, being seen at the Middlesex Hospital.

(6) Fecal fistula is often the sequel of an attempted radical cure of *artificial anus.*

Prognosis.—When a fecal fistula is due to a wound, it generally closes spontaneously; when due to hernia, the prospect of recovery is good. When the bowel is obstructed by the pressure of a growth, or by adhesions or stricture, the chance of cure must largely depend upon the possibility of removing the cause of obstruction; it is generally very improbable, often quite impossible, to close the fistula arising from obstruction.

Diagnosis.—There is no difficulty in diagnosing most of these cases, because the fecal character of the discharge at once declares it in an external fistula, and the passage of fecal matter by the vagina, urethra, stomach, or lungs, declares it in many of the internal. Blind fistulæ, and fistulæ opening into abscesses, may, however, be undetected for some time or altogether, and fistulous openings between different parts of the intestine may not be suspected.

Nor can the situation of the intestinal opening be always rightly inferred from the character of the matter which escapes. The negative evidence of an inodorous or non-feculent discharge is suggestive of some part of the jejunum, or quite upper part of the ileum, whilst the positive evidence of semi-solid feces points to the large intestine, and pure bile to the duodenum or upper part of the jejunum. But it must be remembered that fecal matter sometimes escapes from the stomach, owing to a communication with the colon, whilst in other cases fluid taken by the mouth may in a few minutes be discharged through a colic fistula; as in a case which I have elsewhere quoted, in which the transverse colon communicated with the duodenum as well as with the surface of the abdomen. I once performed right colotomy on one of my colleague Dr. Powell's patients, who was suffering from abdominal distension due to obstruction—as I thought, in the transverse or splenic flexure of the colon. The operation was successful in completely relieving the patient from his sufferings, and in prolonging life for some days; but the post-mortem examination proved that my diagnosis was wrong. The obstruction was due to the adhesion together of some coils of small intestine, between one of which and the ascending colon just below the cæcum a free communication existed, so that after the operation the contents of the small intestine mixed with those of the cæcum and colon, and were drained away through the operation wound.

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[1] Lond. Medical Journal, p. 188. 1784.

Treatment.—Cleanliness, the recumbent posture, and some flat, equable compression upon the parietes over and beyond the fistula, should be employed. I have tried paring the edges and bringing them in contact with hare-lip pins and sutures, and also the application of caustics, but without success; and yet, after failure with these methods, very great improvement has followed the enforcement of the supine position, with compression, and the proper selection of food. Sheet lead, or gutta-percha, or a large flat air-pad attached to the centre of an abdominal belt, when the fistula is in the front of the abdomen, will be found useful for exercising pressure. Mensel, of Gotha, has cured two cases of intractable intestinal fistula by abdominal incision, followed by suture of the fistulous opening of the intestine, after dissecting it away from the edges of the parietal opening. Catgut sutures were employed for the closure of the bowel, the bowel was dropped back into the abdominal cavity, and the external incision was closed in the usual way. Convalescence was complete in one case in ten days, and in the other in fourteen days.[1] The food should be light and easily digested, and should consist of soft animal and farinaceous solids; for liquids are much more apt to pass readily through the fistula, and vegetable substances are not readily absorbed. Constipation should be avoided. By keeping on his back, the patient aids the action of gravity to deter the intestinal contents from entering the fistula. The excoriation and eczematous inflammation produced by the acridity of the discharges are best prevented by using zinc or spermaceti ointment, on lint placed widely around the opening. Sulphate of iron lotion (100 grains to the pint of distilled water) is sometimes very beneficial, but when there is much smarting or irritation, warm lead lotion is the best application.

FALSE ANUS; COMMONLY CALLED ARTIFICIAL ANUS.

The term "artificial anus," as nearly all writers on the subject have pointed out, is ill adapted for those varieties of the disease which are not the designed result of surgical operation. Nor are "abnormal anus," suggested by Dupuytren, nor "anus contre nature," used by Jobert, any better, for the reason that the genuine "artificial" anus of surgery is equally "abnormal" and "unnatural" with the rest. Many French writers have superseded the word "artificial," as applied to cases not the result of operation, by the word "preternatural," but as this implies a something which is strange and unheard of, it is not suitable; whilst the term "accidental,"[2] also employed by Jobert, is only suitable to cases which result from external violence. I have, therefore, proposed the word "false," and shall here employ the expression "false anus" for all abnormal external communications with the bowel which have not been designedly established by the surgeon, and which are too large to be included under the term "fecal fistula." "Aberrant" would be a name well adapted for such openings, for the word implies a deviation from the right course through some error or fault, and in this sense is actually in use in natural history. But it is longer and less English than "false." "Artificial" anus is thus reserved for, and ought to be restricted to, a new and abnormal outlet formed by surgical art for the purpose of affording relief in cases of insurmountable obstruction in the bowel below, and of imperforate anus. In this sense there are three classical forms of artificial anus: 1. Lumbar; 2. Iliac; and 3. Perineal. Exception has also been taken to the word anus, in all these cases; and not without ground, for in none of them does the opening possess a sphincter.

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[1] Lond. Med. Record, May, 1883, p. 186.

[2] In his excellent work on Surgical Diseases of the Intestinal Canal, Jobert speaks of two forms of "anus contre nature:" 1. The *accidental*, which follows gangrened hernia and intestinal lesions, and 2. The *original*, which is due to some vice of development.

A false anus differs from a fecal fistula in the greater size of the intestinal and external orifices, in their greater proximity to one another, and in the much greater quantity of intestinal contents which passes through them. The characteristics of a false anus are that: (1) the whole, or the greater part of the fecal matter escapes; (2) the will of the individual has no influence in retarding the escape; (3) the swollen, and more or less protruding, mucous membrane of the ends of the intestine becomes still more protruding during the escape of the fecal matters; (4) the ends of the bowel are adherent to the surrounding parts by false membrane.

Fig. 1115.

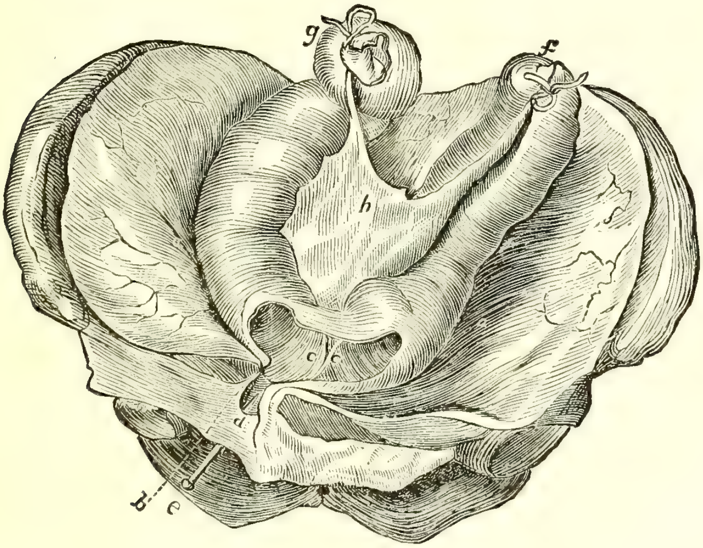


Diagram of the relations of a false anus resulting from sloughing of a knuckle of ileum. *a a*, peritoneum covering iliac fossæ; *h*, point where peritoneum forms part of infundibulum; *c*, *éperon*; *d e*, fistulous track and outlet of false anus; *f* upper part of gut; *g*, lower part of gut; *h*, mesentery. (After Scarpa and Otis.)

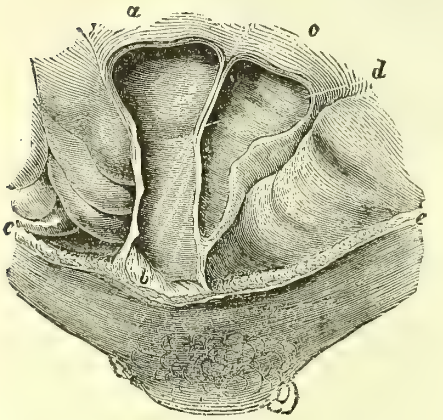
Situation.—A false anus may be situated in any part of the abdomen: as the result of external violence it is met with in the loins, hypochondria, umbilical, iliac, hypogastric, and sacral regions; but as the result of disease it most commonly affects the hernial regions—inguinal, scrotal, femoral, and umbilical—and more particularly the first two. Any point in the intestinal canal may be the seat of the internal opening, but it is most frequent in a part which, being free to reach the hernial apertures, can thus be strangulated in them; consequently the ileum is most frequently affected in this way, though the large intestine is very often involved as a result of traumatic lesion.

Causes.—First and chief amongst the causes of false anus is hernia, neglected and operated upon too late, or not operated upon at all; thus by gangrene or ulceration, or by either of these processes combined with fecal abscess, the larger proportion of the cases seen in civil practice are formed. Second, but much more rare in civil life, though by no means infrequent in warfare, come contused, incised, lacerated, and gunshot wounds. Third, foreign bodies arrested in the intestine lead to adhesions and perforations, followed by fecal abscess, and this in turn by either a fecal fistula or a false anus. Fourth, abscess, whether commencing in the parietes and involving the intestine secondarily, or commencing in ulceration of the intestinal mucous membrane, and subsequently implicating the parietes. Fifth, false anus may be congenital, the result of some error of development. It is then usually situated at the umbilicus, or lower down in the linea alba. The openings in some of these congenital cases are so small, the amount of intestinal contents which passes through them so insignificant, and the consequent distension so considerable and fatal, that fecal fistula, not false anus, is the proper name for them. Sixth, Jobert alludes to a fatal case of false anus, caused by a surgeon who mistook a fecal accumulation for an abscess, and plunged a bistoury into the swelling.

The whole or any part of the circumference of the bowel may be severed by the injury or disease which causes the false anus. Upon the extent of the lesion depend both the gravity of the case and the nature of the treatment to be adopted.

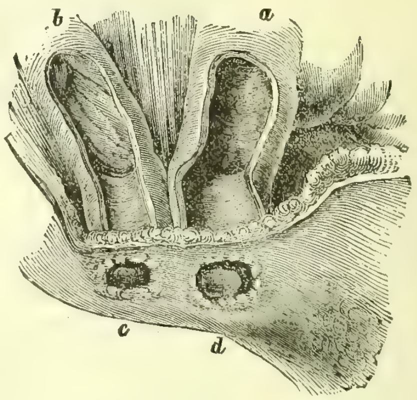
Pathological Anatomy.—The external orifice varies much in size and appearance. It is usually single (Fig. 1116), but may be double (Fig. 1117), and has been described as cribriform or sieve-like. Dupuytren observes:—

Fig. 1116.



Intestinal fistula from Dupuytren's collection. *a*, upper part of intestine; *b*, aperture of the same; *c*, lower portion of intestine; *d*, projecting valve closing entrance to lower portion of intestine. (After Teale.)

Fig. 1117.



Intestinal fistula from Dupuytren's collection. *a*, upper portion of intestine; *b*, lower portion; *c*, aperture of lower portion; *d*, aperture of upper portion. (After Teale.)

The opening, in whatever way occasioned, is almost always roundish, but sometimes of an irregular shape. Its diameters vary from a few lines to an inch or more. In the majority of persons its edges are thick, depressed, adherent to the subjacent parts, inclined towards the abdominal cavity, and immediately continuous with the mucous membrane of the bowel. A reddish circle denotes the place of their junction. The neighboring integuments have radiating furrows in them, *en cul-de-poule*, analogous to what is observed near cicatrices in general; and notwithstanding the most minute attention to cleanliness, the matter evacuated irritates the skin, bringing on an erysipelatous redness, or excoriations of variable depth.

The distance between the outer opening and the lower edge of the intestinal aperture, varies with the cause of the affection and the thickness of the abdominal walls. It is usually from one-third to one inch, but it may be two, or even three inches. The two ends of the bowel are sealed by plastic lymph to the parietal peritoneum around the outer orifice, and thus the peritoneal cavity is safely shut off. The extent of these adhesions varies, but they are not often more than from one-twelfth to one-quarter of an inch wide. If they be feeble, the intestine may be pushed, torn, or dragged away, and completely separated from the parietes, and the patient will then die of fecal extravasation into the peritoneal cavity; but in old cases the adhesions are apt to yield gradually to the constant dragging action of the mesentery, without any ill effect resulting, and the gut becomes, perhaps, as Dupuytren proved it might, completely restored to its free and floating condition. When the false anus results from disease, the formation of this barrier of adhesions precedes the sloughing of the bowel; when due to injury, the barrier has to be thrown up around the wounded part, and until this has been completed, there is danger of effusion into the peritoneum. The adhesions never extend far along the extremities of the bowel, which, being merely contiguous, leave between them a *cul-de-sac*, into which, in some instances, the viscera press so as to give rise to a hernial protrusion, which pushes forwards and otherwise complicates the false anus.

The two ends of the spoiled bowel, which are thus attached to the deep margin of the external opening, vary in their relation to one another. Sometimes, if the lesion of the wall of the bowel is not extensive, they are very obliquely placed, and then there is a good prospect of the intestinal contents passing from the upper to the lower portion, and so reaching the anus, and favoring the spontaneous closure of the abnormal opening; sometimes they are quite parallel, or, in the stereotyped phrase, side by side like the tubes of a double-barrelled gun. As Dupuytren observes, the two terminating portions of the bowel pass into the abdomen, sometimes crossing, sometimes coiling over one another; in other instances running parallel, but most frequently diverging at a more or less acute angle. Lastly, they terminate in bending more and more to become lost in the convolutions of the intestinal canal. Each end of the gut opens by a distinct orifice, separated by a spur or septum more or less pronounced, to which Dupuytren gave the name of "*éperon*," and Scarpa that of "the promontory." This spur consists of the mesenteric side of the bowel, if it has been spared; and if not, of the contiguous and now united mesenteric sides of the two ends of the bowel. In the latter case, the *éperon* forms a complete barrier between the upper and lower orifices, and intestinal matter cannot pass from one to the other except by describing a kind of semicircular course outside them, and in the infundibulum of Scarpa, to be presently mentioned. The *éperon*, after a time, does not divide the orifices equally, but is propelled towards the lower part of the bowel by the pressure of the matter passing constantly through the upper orifice; thus the upper opening increases in size as time goes on, and the lower one contracts until by degrees it becomes so shut off that it is only detected with difficulty. The two ends of the bowel undergo other important changes in time, besides those of size. The upper one, from its incessant activity, receives an extra supply of blood, and in consequence increases in volume and strength; and this excess of life is imparted to the mesentery, and to the glandular and muscular structures of the bowel. The lower portion, on the other hand, atrophies, though it is rarely, if ever, obliterated entirely;[1] but its muscular, mucous, glandular, and mesenteric apparatus all waste, and, to such a degree that, as Dupuytren has pointed out, after some years the difference between the upper and lower ends of the intestinal tube is so great that while the former seems to be that of an adult, the lower looks as if it belonged to a new-born infant. Jobert says of it, "qui est revenu sur lui-même, comme un intestin de chat, et qui ressemble parfaitement à un intestin grêle d'enfant."[2] Otis[3] says that a feature common to all the cases of abnormal anus, the result of wounds during the war, was the absence, or but slight development, of the crescent-shaped septum, or *éperon*, commonly found in cases of false anus following gangrened hernia. That this septum is not a necessary or a frequent consequence of the destruction of a limited portion of the intestinal wall by injury, though at variance with Scarpa's teaching, is, Otis thinks, the most important practical lesson deduced from the many instances of spontaneous recovery from extensive wounds of the large intestines.

According to Scarpa, in a false anus resulting from gangrene of a hernia, the ends of the bowel are embraced by a sort of membranous funnel (*entonnoir membraneux*) or *infundibulum*, the other extremity of which is attached to the integuments. The interval which exists between the two ends of the infundibulum is sometimes obliterated, sometimes sinuous, and at other times straight. This infundibulum opens upon the surface, generally by a single, round, or more or less irregular aperture. It is organized exactly like a fistulous track, and is lined by a sort of mucous membrane, which is continuous with that of the intestine, but which has neither follicles nor villosities like the latter. Though thin, this false membrane yet serves to protect the surrounding parts from infiltration with fecal matters. If the hernial sac has not been destroyed by gangrene, or by ulceration and contact with the fecal matters, the infundibulum is formed by this sac, which becomes coated with plastic lymph. The funnel may be short, especially if the bowel descends very low, or actually reaches the skin; on the other hand, it may be very long, and then the fecal matter has to course through a long passage to reach the external opening. Dupuytren, Jobert, and others, confirm Scarpa's description of this infundibulum, which, however, does not exist in traumatic false anus, nor in all cases the result of gangrened rupture. When the funnel is not present, the gut is attached to the margin of the opening in the muscles and skin of the parietes. Repair seems to be more rapid, and spontaneous cure more probable and perfect, in cases in which the infundibulum is long and large, than in others; and Scarpa has pointed out that the breach in the intestine is never repaired by the orifices of the two ends of the gut reuniting, as they are at a very acute angle to one another, but that it is by means of the funnel-shaped cavity that the two parts of the bowel communicate, the fecal matter passing in a semicircular manner through the funnel from one side of the *éperon* to the other.

Symptoms.—These consist in the discharge, through the abnormal opening, of fecal matter, mucous substances which have not undergone absorption, and the different secretions which are poured into the intestine or produced by it; and the ill consequences which follow from this discharge. Colicky pains are often experienced, and are attributed by Jobert to the inability of a great part of the bowel to perform its usual functions. The inflammatory affections of the skin around the opening have been already alluded to; and in old, long-standing cases, callosities occur from the irritation and inflammation excited by the acridity of the constantly escaping matters. Differences in the character of the matters which escape, and in the length of the interval between taking food and the flow from the false anus, depend upon the exact situation of the intestinal opening: the nearer the stomach the less feculent and more chyle-like the discharge, and the shorter the interval before its escape. Although there are not a few cases in which the health and strength of patients thus afflicted have been preserved, in a greater number the ill effects upon the constitution are very marked; loss of strength, rapid emaciation, and death from inanition, are the result of the food remaining too short a time in the digestive tube. Another effect of the same cause is witnessed in the very voracious appetite which these patients sometimes have.

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[1] The case of M. Bégin, quoted by nearly all writers, shows that this obliteration is not impossible. The patient died at eighty, having for forty years had a false anus in the left groin, communicating with the arch of the colon.

[2] ["Which is contracted, like the intestine of a cat, and which exactly resembles the small intestine of a child."]

[3] Med. and Surg. History of War of Rebellion, Part II., Surg. Vol., p. 109.

Terminations.—Desault, Leblanc, Hoin, and Jobert have observed patients thus affected die from inanition. Jobert speaks of death from rupture of the intestine due to crossing of the ends of the bowel; Dupuytren, of two cases seen by him of death from rupture of bowel and escape of fecal matter into the peritoneum. Strangulation of the ends of the intestine is sometimes the cause of death, and is caused either by over-lapping or crossing of the ends of the bowel, or by prolapse. Puy, of Lyons, saw two cases of death from this cause, and Hoin, Leblanc, and Sabatier cite similar instances.

Though it is true that in the greater number of cases which have resulted from the total destruction of a convolution of the bowel, the false anus persists through life, and patients have lived 15, 20, and even 40 years with it; it is also true that in some cases in which the surgeon's skill has proved powerless, nature has effected a cure most unexpectedly. Pipelet[1] gives a case, the result of a crural hernia, in which the cure was effected by false membrane, and the ends of the intestine thus closed in were withdrawn into the belly. Wedemeyer, of Hanover, relates a case of a woman, aged 32, with a false anus from a gangrened rupture which had resisted all attempts at cure. She became pregnant, and as pregnancy advanced the fecal discharge diminished; towards the close of gestation nothing escaped except a little pus and serum; and in two months after her confinement the opening had securely healed. It was very different in a case in which I had operated for crural hernia, and was subsequently consulted on account of intestinal obstruction during pregnancy:—[2] A false anus followed the operation within a few hours, from sloughing of the part of the bowel which had been strangulated, but a spontaneous cure occurred within six weeks. Some two years afterwards the woman became pregnant, and between the fourth and fifth months of pregnancy, intestinal obstruction attended by severe symptoms occurred, owing as we supposed to interference with the adherent coil of bowel by the enlarging uterus. Abortion was consequently induced by sponge tents, and complete recovery ensued. Some years afterwards I heard through the family in whose service she had lived (her family medical attendant having died, and she having changed her place of residence), that this patient had died of bowel-obstruction during pregnancy; and from my experience of her previous attack, I do not doubt that the cause of death was the pressure exerted by the uterus upon the bowel which had been the seat of the false anus, and which still remained adherent in the femoral region and was bent at too acute an angle to allow of the passage of the intestinal contents. In the case in Sir A. Cooper's practice related by Mr. Hey, precisely the same sort of false anus as in my case, namely, following sloughing of a femoral hernia, was spontaneously cured, and the woman went through the efforts of parturition afterwards without ill effects.

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[1] Mém. de l'Acad. de Chir.

[2] Lancet, Feb. 4, 1871, p. 150, Case III.

Finally, other evils besides that which my case illustrates may happen after the complete cure of a false anus. Sabatier relates instances of death from rupture of the intestine, due to swallowing indigestible substances which could not pass through the part at which the false anus had been situated. Scarpa records a case which ended in death, as follows:—A young man who was almost cured of his false anus ate gluttonously of crab, demolishing not only its claws but their crustaceous covering; death ensued, and at the post-mortem examination the upper part of the bowel was found enormously dilated, and the lower part contracted; fecal matter had escaped into the peritoneal cavity, and there was a perforation at the upper part of the ileum through which portions of the crab were being discharged.

Complications.—(1) *Prolapse of the superior orifice* is the most frequent. It sometimes attains a great magnitude, being a foot or even more in length. It varies at different times, as in a case recorded by Sir W. Lawrence, of a man aged 60, who had voided his feces entirely through the groin for seventeen years. The projecting part was sometimes 4 inches, sometimes 8 or 10 inches long; it was equal in size to the forearm, and bled copiously. As a rule, the diameter does not exceed two and a half inches or thereabouts; its shape is conical or nearly cylindrical, being contracted at its base; and the mucous coat is swollen and congested.

(2) *Prolapse of the inferior orifice* is less common and less extensive than prolapse of the upper. It seems to be caused by peristaltic movements propelling the mucous excretion of the lower part of the intestine towards the false anus. Sabatier[1] has related two cases of prolapse of the lower orifice. One was that of a soldier, with an abnormal opening allowing of only partial escape of feces through it. After a colicky seizure, he found a nipple-like protrusion which soon reached the size of a fist, and ultimately, though it varied from time to time, was generally six inches long and one and a half inches in diameter. The man enjoyed good health, and was hearty and strong.

(3) *Prolapse of both orifices* has been represented by Sir A. Cooper in the second plate of the first part of his work on Hernia (second edition). Bourgery[2] has also illustrated this condition, and two cases are quoted by Sir Wm. Lawrence[3] from Albinus and Sabatier.

(4) False anus may be complicated with *hernia* in the manner which has already been alluded to.

Treatment.—The two chief indications are to remove the obstruction caused by the *éperon*, and to close the external opening. The treatment may be considered under the heads of Palliative and Curative Means.

I. *Palliative Treatment.*—(*a*) Pressure by a truss so applied as to allow of the periodical evacuation of the bowel. (*b*) The adaptation of a receptacle of which numerous patterns in numerous materials have been tried. (*c*) Colomb's plan of making the upper end communicate with the lower by means of a curved gum-elastic tube, two or three inches long.

II. *Curative Means.*—(1) To *remedy any existing complication* by (*a*) careful attention to diet, as mentioned in the treatment of fecal fistula; (*b*) an occasional evacuation per anum, by the use of enemata; (*c*) prevention or relief of prolapse by position and pressure; and (*d*) prevention of premature closure of the external opening, which would lead to partial or complete intestinal obstruction.

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[1] Mém. de l'Acad. de Chir., tome v. p. 398.

[2] See Teale's article in Costello's Cyclopedia of Practical Surgery, vol. ii. p. 202.

[3] Treatise on Ruptures, p. 419.

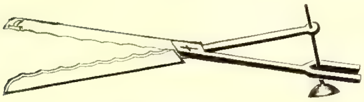
(2) To *diminish or remove the obstruction* caused by the *éperon.*

(*a*) *Compression of the éperon* by Desault's plan, which consisted in the introduction into the two ends of the bowel of long tents, so as to dilate the lower part of the bowel and efface the angular projection between it and the upper. Desault placed also a plug of lint in the external aperture, to prevent the escape of fecal matter, and administered laxatives and clysters. He perfectly cured a sailor by this means. Larrey successfully adopted this plan, as did Scarpa with partial success. The Dublin method consisted in using a "propeller," which was introduced into the ends of the bowel, and which, whilst it retained the anterior wall of the bowel against the abdominal parietes, pressed back the *éperon* away from them.[1]

(*b*) *Perforation of the Éperon.*—Schmalkalden, in an inaugural dissertation published at Wittemberg, in 1798, recommended the passage of a ligature through the base of the *éperon*, upon which traction was to be made so as gradually to cut through the tissues. Dr. Physick,[2] of Philadelphia, employed a similar process. Dupuytren,[3] in May, 1813, passed a seton through the base of a very prominent *éperon*, in a case in which the two ends of the bowel were lying parallel to each other. He gradually increased the size of the seton until at length the whole depth of the *éperon* was cut through. A free communication was thus established between the two ends of the bowel; but as complete cure did not forthwith result, he cut away portions of the *éperon* with scissors, set up peritonitis, and the man died. He afterwards abandoned this mode of treatment. Such a proceeding is only applicable where perfect adhesion has occurred between the two serous layers of the coats forming the *éperon:* where this has not occurred, the transit of the needle and thread would cause a double perforation of the peritoneal cavity.

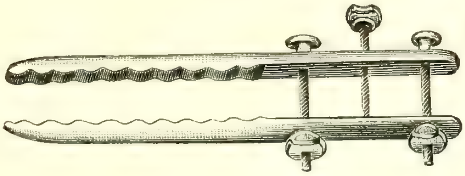
(*c*) *Destruction of the Éperon by means of the Enterotome.*—This is the method of Dupuytren; the enterotome devised by him (Fig. 1118) consists of three pieces, viz., two branches, which lock like the blades of a midwifery forceps, and a screw, whereby the handles can be approximated or separated. The male blade is received, to the depth of a line, into a groove in the female blade. One blade is introduced into one part of the bowel, and the other blade into the other end of the bowel, to a depth varying from one to four inches. The blades are then locked, and approximated and held together by the screw-piece of the enterotome. The effects of this instrument are to augment the length of the parallelism of the two ends of the intestine and of their intermediate septum, and to bring about adhesion of the sides of the two pieces of bowel, and then complete division of the parts compressed by the teeth of the blades. The instrument falls off about the eighth day, and with it the included portion of the intestinal tissue, in a dry, parchment-like state.

Fig. 1118.



Dupuytren's enterotome.

Fig. 1119.



Blasius's enterotome.

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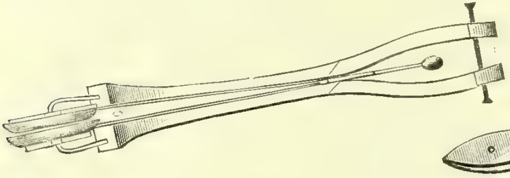
[1] See Dublin Med. Press, vol. xiii. p. 305.

[2] See Dorsey, Elements of Surgery, 1813.

[3] Mémoire sur les anus contre nature, p. 286.

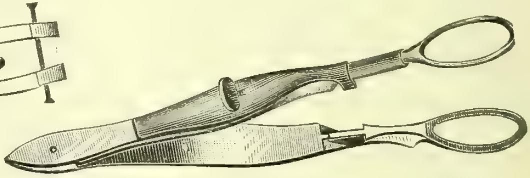
Dupuytren gives the results in 41 operations performed by himself, Lallemand, and others: 3 patients died, 1 from fecal effusion, 1 from indigestion, 1 from peritonitis; 9 had fistula remaining; 29 were completely and permanently cured, in periods varying from two to six months. Colic, nausea, and vomiting occurred in some of the 38 cases of recovery, but the majority of the patients did not suffer any severe symptoms. In three-fourths of the cases thus operated upon, the false anus was caused by gangrenous hernia; in the other one-fourth by wounds of the abdomen, with loss of substance of the bowel. Heimann,[1] of Dornhan, gives statistics of 84 cases of "artificial," that is, false anus, treated by Dupuytren's method. In 76 of the 84 cases the result was more or less favorable: in 50 the opening completely healed up; in 26 a small fistula was left, which could be well closed with a compress, and the patients could resume even arduous occupations. In one of the 8 fatal cases, resection of the bowel had been subsequently performed. If this case is excluded, we have 83 cases with only seven deaths, a mortality of about 8.5 per cent., which compares most favorably with the 37 to 50 per cent. mortality of *resection of the bowel* mentioned further on, and shows Dupuytren's method to be a very successful operation, and one which ought to be preferred to a decidedly much more dangerous, if much more rapid procedure. Blasius, Liotard, Delpech, Reybard, Gross, and others have modified Dupuytren's enterotome, and Jobert, who recorded several unfavorable results with Dupuytren's instrument, proposed to apply it only with the view of obtaining adhesion, and not division of the septum. It has been pointed out by several writers on the subject, that adhesive inflammation does not always take place at the periphery of the enterotome, even after it has been applied in the most judicious manner; and further, that in some cases it is almost impossible not to include between the branches of the instrument some free loop of sound intestine. And yet, from Dr. Heimann's statistics, it appears that in only two cases (Dupuytren's and Gherinis's) did perforation occur, and in only one did death result from peritonitis extending from the portion of peritoneum included in the clamp. Heimann, as others before him have done, points out the danger of employing the enterotome too soon after the establishment of the false anus, and the advisability of screwing it up gradually, so that only a small portion of the spur may be compressed each time. The existence of a spur should of course be ascertained before having recourse to this mode of treatment.

Fig. 1120.



Reybard's enterotome.

Fig. 1121.



Gross's enterotome.

The persistence of fecal fistula in a certain proportion of cases operated upon, was recognized and regretted by Dupuytren, who urged his juniors to set to work and find a means of promptly, and without danger, causing an opening in the skin, when useless, to cicatrize, in all cases. Mr. A. E. Barker, of University College Hospital, London, has adopted a plan described and figured by himself in the Lancet.[2] After dividing the *éperon* with

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[1] Lond. Med. Record, May, 1883, p. 187.

[2] Lancet, Dec. 18, 1880, p. 971.

Wells's artery forceps, he introduced an India-rubber valve into the bowel in such a manner as to close the intestinal aperture, and fastened each end of the valve by means of a wire suture passed through the parietes of the abdomen. The valve was thin and flexible, and the pressure of the feces against its under surface was relied on to make it fit still more closely to the curves of the opening. His patient made a complete recovery, but it is uncertain to what extent, if any, the valve contributed to the cure.

(3) Another method of cure is to *obliterate and close the external opening.* This has been attempted in several ways: (*a*) Pressure by means of an elastic truss, or linen compress, which ought to extend considerably beyond the limits of the external opening. (*b*) The use of caustic, the actual cautery, or the thermo-cautery—a plan particularly recommended by Dieffenbach, who cured a case by thus destroying the edge of the bowel at its junction with the skin, and a considerable portion of the mucous membrane within the orifice, but without acting on the skin itself. (*c*) Suture, after freshening the edges of the opening. (*d*) Autoplasty, which consists in covering in the opening by a piece of skin detached from the neighborhood, and united by threads to the external aperture. Jobert, after failing with each of the above-named measures for closing the external opening, succeeded by the following manner: A portion of skin was dissected away at each side of, but at some little distance from, the artificial anus, and the raw surfaces were brought into contact in front of the opening, and secured by six twisted sutures. Thus was formed a kind of bridge over, with an open angle above and below, the false anus. After the escape of a little fecal matter from both lower and upper angles, the parts united in front of the opening, and a cure was perfected after some months.

(4) *Resection and circular suture of the intestine* has recently been somewhat largely practised both for gangrenous hernia and for false anus. From a critical review of this subject by MM. Bouilly and G. Assaky,[1] we learn that in the ten years following 1873 there were thirty-six cases of resection for gangrenous rupture, viz.: 21 femoral, 11 inguinal, 1 umbilical, and 3 unstated. The mortality was 50 per cent.; there were 16 complete recoveries, persistent fistula in 1, and a false anus in 1. There were 29 resections for false anus, 17 of which were successful, 1 failed, and 11 terminated fatally. In 26 cases the false anus was consecutive to gangrenous hernia. Enterectomy followed by enterorraphy, if successful in gangrenous hernia, spares the patient the disgust and misery of ever having a false anus. The indications for practising it are, M. Bouilly considers, the following: 1, when the general condition is such that the patient can stand the operation without syncope, shock, vomiting, or pulmonary congestion; 2, when no general peritonitis and no fecal extravasation into the peritoneal cavity have occurred; 3, when the gangrenous intestine and mesentery can be drawn out, and resection practised in healthy parts of gut; 4, when the calibres of the resected ends are not greatly different. As regards the operation for a false anus, M. Bouilly concludes that the operation is indicated: 1, in cases in which compression, the application of the enterotome, sutures, autoplasty, and other methods of treatment have failed; 2, when the precise condition of the bowel involved cannot be made out, and also, when there is crossing of the ends of the bowel, great inequality in calibre, or several perforations near together; 3, when extensive prolapse of mucous membrane exists, with or without invagination of the subjacent part of intestine; 4, when there is considerable prolapse of one or both ends of the intestine; 5, when a false anus has no spur-like projection between the upper and lower ends of the gut, and there is so large a loss of substance that

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[1] Revue de Chirurgie, Mai et Juillet, 1883. See also Am. Journ. of Medical Sciences, October, 1883.

suturing the borders of the opening cannot close it. The description of the operation of enterectomy will be found in the article on Intestinal Obstruction.[1]

Entero-Vaginal Fistulæ.

Communications sometimes occur between a coil of small intestine and the vagina, as a result of injury or disease. Jobert mentions a case in which a contusion of the abdomen was followed by such a fistula. Punctured wounds from the vagina, and ulceration commencing in the mucous coat of the bowel, or following adhesions between intestine and vagina, and set up in some other way, are known causes of entero-vaginal fistula. In other cases, the condition is congenital, and due to an imperforate rectum; but in these the communicating part of the bowel is the large intestine. The sigmoid flexure cæcum, and transverse colon, rarely open into the vagina, but such fistulæ are not impossible.

Symptoms.—These are the discharge of feces per vaginam, and the loathing, inconvenience, and misery, and the interference with sexual intercourse, which such a condition produces.

Treatment.—This may be palliative or curative. The palliative consists in wearing a properly fitting pad or pessary, which should be removed from time to time for cleansing both it and the vagina. If the communication is with the sigmoid flexure or transverse colon, right colotomy would be a preferable substitute. A plastic operation upon the vagina may be tried, but hopes of success cannot be great. If all other measures fail, and the fistula is large enough to allow of a free escape of fecal matter into the vagina, and to give rise to great discomfort, or perhaps, even to danger, enterectomy and circular suture, by abdominal section, should certainly be performed. The subject of recto-vaginal fistula is dealt with in other articles.

Foreign Bodies in the Stomach and Intestines.

By "foreign bodies" are meant such as are incapable of being influenced by the digestive processes. Poland[2] groups them under the following heads:—

(1) Pointed bodies, such as needles and pins. (2) Elongated, irregular and cutting bodies, such as false teeth, egg-cups, heel-plates of boots, tin-tacks, knives, scissors, forks, spoons, blades, awls, bodkins, nails, slate-pencils, etc. (3) Rounded bodies, such as coins, thimbles, marbles, bullets, and fruit-stones. These are more easily got rid of by passing along the intestinal tube than those of either the first or second class. To these we must add: (4) Hair, wool, cocoa-nut fibre, etc., which are apt to accumulate and become matted together into large, firm, rounded balls.

The *symptoms* which are excited, vary according to the nature and number of the foreign substances. Sometimes the bodies will produce little or no inconvenience, but will pass on through the whole intestinal tract and be discharged *per anum*. Sometimes they remain for a long time, or throughout the rest of life, without giving rise to any marked discomfort. In other instances, especially if the bodies be pointed, they set up inflammation of the stomach or bowels, cause ulceration of their coats, or pierce them and excite general, or circumscribed peritonitis; or, after leading to adhesions between viscera and parietes, they may induce parietal abscesses. Occasionally they escape entire through the abdominal wall, or are removed by the patient or surgeon after having partially passed through it.

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[1] Reference should be made for information on this subject to the celebrated essay by Dupuytren, in his Leçons Orales de Clinique Chirurgicale; to Jobert's work, Maladies Chirurgicales du Canal Intestinal, tome ii. p. 80; to Mr. Teale's article on Intestinal Fistula, in the 2d volume of Costello's Cyclopedia of Practical Surgery; to Prof. S. D. Gross's excellent work on Wounds of the Intestines, chapter iv.; to Sabatier's Mémoire sur les anus contre nature, in the Mém. de l'Acad. Royale de Chir., tome v. p. 592. 1774; to Scarpa's Treatise on Hernia, translated by J. H. Wishart; to the Dictionnaire de Médecine, 1833, article "Anus Contre Nature;" to Dupuytren's article in the Dict. de Médecine et de Chirurgie Pratiques, tome iii. p. 267, and to many other French and German works to which references will be found in the above named works.

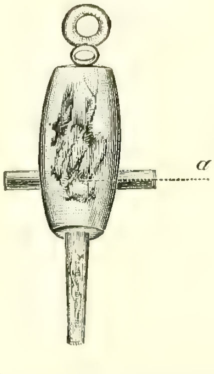
[2] Prize Essay.

Foreign Bodies in the Stomach.—As a rule, the first symptoms are vomiting and pain in the epigastrium; succeeded by a sense of weight and fulness, attacks of indigestion, and very possibly, if the parietes are thin, by the detection, on external manipulation, of the presence of the foreign body. Hæmatemesis occasionally occurs, and sometimes acute gastritis. In other instances, after a long period of pain, indigestion, loss of appetite, and sense of weight or oppression at the pit of the stomach, the patient dies of exhaustion.

In some of the reported cases it is quite astounding to observe how many and what large-sized substances have been discovered in the stomach after death, and that, despite their presence for months or years, the persons have died from other causes. In some instances, large numbers of pins or needles are said to have been swallowed, and afterwards eliminated, separately and spontaneously, at different parts of the body; but such statements, made as they generally have been by hysterical women, must be received with caution,[1] though possibly not with such absolute incredulity as the statement of the man who, having swallowed a half-sovereign in gold, asserted positively that he had expelled it per anum in half-penny and penny pieces. Artificial teeth are the bodies most commonly swallowed by accident, and they are now so generally worn that I never suffer an anæsthetic to be administered without previously ascertaining that the patient either does not wear artificial teeth or tooth-plates, or has removed them.

Many of the persons who swallow foreign bodies, not by accident, are insane or thieves. Jugglers have often swallowed them accidentally, and thieves intentionally; others again have had the substances forced down their throats. No articles are so frequently swallowed by thieves as coins, and these usually pass on into the stomach and bowels without any mishap. Occasionally a thief attempts to get rid of a more bulky booty. There is in the museum of the Middlesex Hospital a specimen showing an entire mutton-chop, impacted in the pharynx opposite the back of the larynx; death was instantaneous. The man had endeavored to bolt the morsel whole, in a tavern close to the hospital. Knives and other steel and iron bodies, when retained for some time in the stomach, undergo a slight degree of solvent action; this has been proved by the loss in weight of the retained bodies, and by the ferruginous staining of the stools. I am aware of a case in which a school-boy swallowed an aluminum pencil-case of telescopic make, such as is worn as a trinket; it was swallowed in its

Fig. 1122.



Cannon-shaped pencil passed by the rectum; *a*, patches of erosion. (Half-size.)

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[1] See an interesting paper on this subject by Mr. Alban Doran, in St. Barth. Hosp. Rep., vol. xii. pp. 118 *et seq.*

closed state, and thus measured about 4 inches; thick soups, pudding, and bread, were partaken of freely, and in five days the foreign body was passed *per anum*, much changed in appearance from the action of the gastro-intestinal secretions, which had freely acted upon it, and even upon the lead which it contained when swallowed. The case was brought to my notice by a former pupil, Mr. W. H. Forbes, to whom I am indebted for the accompanying drawing of the pencil-case after its discharge from the bowel. M. Hévin, in his exhaustive memoir, has related some very interesting cases of persons who had swallowed knives, etc., and whose stomachs were opened for the removal of the foreign substances. Poland has collected six very interesting cases of foreign bodies in the stomach:—

One is the case, described by Dr. Marcet,[1] of the sailor who between June, 1799, and his death in Guy's Hospital in March, 1809, from perforation of the stomach, swallowed a large number of clasped knives, several of which he passed *per anum* and others of which he vomited. The stomach, with between thirty and forty fragments of knives, was removed after death, and is now in Guy's Hospital Museum. Another case is related by Dr. Barnes, of Carlisle, of a juggler, who on November 17, 1823, accidentally swallowed a table knife with a bone handle, together about 9 inches in length. It remained quiet until January 16, 1829, when he died of gangrene of the duodenum, caused by pressure of the lower end—the handle—of the knife. This knife is in the museum of the College of Surgeons, London. The third case is that of a man, aged 23, a patient in the Peckham House Lunatic Asylum, who swallowed several spoons and spoon-handles, and died, after an interval of five months, from peritonitis and perforation of the duodenum. Thirty-one entire spoon-handles, about 5 inches long, besides four half handles, nine nails, half of the iron heel of a shoe, one screw, four pebbles, and one button—making together a mass weighing 2 pounds 8 ounces—were found in the stomach and duodenum. In the other three cases referred to by Poland, gastrotomy was performed successfully, and in each instance the foreign body was a knife.

On the 9th of April, 1876, M. Labbé removed by gastrotomy a fork, which had been in the stomach of a man, aged 20 years, for two years:—

An incision, four centimetres long, was made along the borders of the ribs, and the stomach, before it was opened, was attached to the abdominal parietes by eight points of suture, passed by highly curved needles at a distance of a centimetre from the circumference of the external wound. On the fifth day after the operation the patient began to take solid food, and the aperture into the stomach was quickly reduced to a mere fistula. M. Labbé lays great stress on the importance of fixing the stomach to the abdominal parietes before opening it.[2]

Sometimes foreign bodies, such as pieces of wool, cloth, string, etc., are swallowed by hysterical women and then vomited at will, to the astonishment and alarm of their friends. Dr. Cobbold has mentioned the case of a lady who consulted him on account of an affliction, which she described as "the worm that dieth not." It appeared, she said, frequently in her vomit. On examination "the worms" proved to be small fragments of differently colored wools which she had swallowed.[3]

Treatment.—Aperients, so often resorted to in these cases, should be avoided. If the foreign body be one likely to pass through the canal, rest in the horizontal position, and the use of food adapted to form a soft, pultaceous surrounding, should be enjoined. Thick soup, farinaceous puddings, eggs, etc., should be taken, and then, at the end of four or five days, if the foreign substance has not escaped *per anum*, its exit may be assisted by a cathartic. Should the substance become fixed across the rectum, gentle and well-directed efforts should be made to extract it. When from its character it is unlikely to pass through the pylorus, or is certain to damage any part of the tube in which it remains, gastrotomy should be advised, and its performance not too long delayed. It must be borne in mind, however, when considering this operation, that many extraordinary recoveries have occurred after the expulsion *per anum* of numerous and awkwardly shaped foreign bodies; but though these cases should make the surgeon deliberate, nothing should cause him to delay, after well making up his mind that the probabilities are all against spontaneous expulsion, and in favor of dangerous retention.

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[1] Med.-Chir. Trans., vol. xii. p. 52.

[2] Gazette Hebdom., 5 Mai, 1876; also, Am. Journ. Med. Sciences, July, 1876, p. 279.

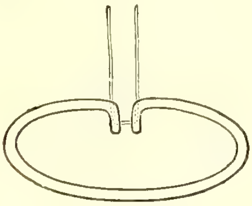
[3] Cases of much interest are related in Bryant's Manual for the Practice of Surgery, and by Pollock, in the article on Injuries of the Abdomen, in the System of Surgery edited by Holmes and Hulke; and for a list of published cases of foreign bodies in the digestive canal, the reader may refer to an article by Dr. Mignon in the Union Médicale, Nov. 1874.

Gastrotomy is to be distinguished from *gastrostomy*. The former is the name given to the operation of opening the stomach with the object of removing a foreign body, and then closing the wound in the stomach, replacing the viscus, and sewing up the external wound with the hope that the patient will return to health and safety, and the stomach to a perfectly normal condition. Gastrostomy, on the other hand, is designed to rescue a person from starvation by making a permanent opening, or artificial mouth, by attaching the walls of the stomach to the abdominal parietes, when from any cause the natural food-channel is obstructed. Both these operations are to be distinguished from a third, sometimes wrongly called gastrotomy, namely the division of the abdominal parietes for exploratory or operative purposes, a procedure to which the term *laparotomy* is now applied.[1]

Gastrotomy must be looked upon as a very successful operation. It is performed in the following manner:—

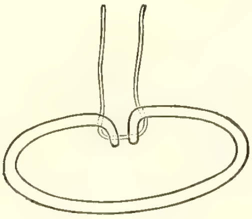
An incision is to be made over the stomach, by carefully cutting through the different strata of the abdominal wall in either a longitudinal or oblique direction, until the peritoneum is reached; the peritoneum should then be punctured, and carefully divided upon a director introduced through the punctured opening. The foreign body should now be felt for by passing the finger tip over the surface of the stomach; the stomach should be raised into the wound by forceps, or by a ligature looped through the peritoneal and muscular coats; and then an opening should be made into the stomach thus fixed, just sufficiently large to allow of the extraction of the foreign body without bruising or tearing the parietes of the viscus. The extraction can be

Fig. 1123.



Lembert's suture.

Fig. 1124.



Jobert's suture.

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[1] *Gastrorraphy* and *enterorraphy* are the closure of wounds of the stomach and intestine respectively by means of sutures, after refreshing the bruised edges of the wounded viscus—a proceeding which, as has been observed, is quite unnecessary in the modern practice of applying sutures to the alimentary canal, whereby inversion and apposition of the serous surfaces are always sought.

effected by a pair of polypus forceps, or by a blunt hook, according to the shape of the foreign body; after its withdrawal, the stomach-wound should be stitched up with a continuous, or Lembert's (Fig. 1193), or Jobert's (Fig. 1194), suture; and the wound in the abdomen should be closed as after ovariotomy. For two days prior to the operation as little food as possible should be taken into the stomach.

If the oblique incision be employed, it should commence below and a little to the left of the xiphoid cartilage, and should be continued for three and a half inches outward, and an inch below the margin of the costal cartilages. If the longitudinal incision be selected, it should be made four inches in length along the outer edge of the left rectus muscle, beginning immediately below the margin of the thorax. Great care must be taken against blood or gastric contents escaping into the peritoneal cavity, and with this object all bleeding from the cut edges of the parietes should be stayed before opening the peritoneum, and all bleeding from the cut edges of the stomach before introducing the sutures. The looped ligature, by allowing upward traction to be made upon the stomach, will help to prevent any escape of its contents, and this may still further be secured by taking care to have an empty stomach at the time of operating. M. Labbé fixed the stomach to the opening in the abdominal wall by eight points of suture before cutting into the viscus, and attached great importance to this step in his successful case above referred to. The after-treatment consists in keeping the shoulders and knees of the patient raised, applying a soft, light dressing, such as absorbent cotton-wool, or boracic charpie, and retaining it with a broad flannel binder. No food should be given by the mouth for three or four days, but the patient should be sustained by nutritive enemata.

Pooley,[1] of New York, and Durham[2] have shown that in nine out of ten cases of gastrotomy recovery has taken place. To the earlier cases tabulated by Mr. Durham, he has since added Labbé's case read before the French Academy of Medicine in 1876; Fleury's case, in which a fork, accidentally swallowed, was removed two days afterwards;[3] and the fatal case of Billé, in which gastrotomy was performed subsequently to œsophagotomy. Still other cases have been recently recorded by Félizet,[4] [Schönborn, and Thornton].

[The following is believed to be a correct list of the operations hitherto reported for removal of foreign bodies from the stomach. Dr. Otis has clearly shown that Mr. Durham, following South, is in error in attributing a successful case to "Shoval," the case in question being identical with that of Schwabe:—

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[1] Pooley, Richmond and Louisville Med. Journal, April, 1875.

[2] Durham, Holmes's System of Surgery, 3d ed., vol. i. p. 799.

[3] Garnier, Dict. Prog. des Sciences Médicales, Paris, 1882.

[4] Much information on gastrotomy will be found in the second surgical volume (pp. 58 and 59) of the Medical and Surgical History of the War of the Rebellion, to which I must refer the reader for references to all the known cases and sources of information. The editor of the History remarks that "in the single example of lodgment of a ball in the cavity of the stomach, recorded during the war, there was no question of gastrotomy, an operation unlikely to be called for in military surgery."

Operator or reporter.	Result.	Reference.
Mathis,	Recovery,	Otis, Med. and Surg. Hist., etc., Second Surg. Vol. [p. 59.
Hübner,	do.	Ibid.
Schwabe,	do.	Ibid.
Cayroche,	do.	Ibid.
Dr. L——,	do.	Ibid.
Bell,	do.	Ibid.
Glück,	Death,	Ibid.
Labbé,	Recovery,	Gazette Hebdomadaire, 5 Mai, 1876.
Fleury,	do.	Garnier, Dict. Prog. des Sc. Méd., 1882.
Billé,	Death,	Berlin. klin. Wochenschrift, 1880.
Félizet,	do.	Deutsch. med. Zeitschrift, and Cinc. Lancet and Clinic, [Feb. 3, 1883.
Schönborn,	Recovery,	Medical Record, May 19, 1883.
Thornton,	do.	British Med. Journal, May 10, and July 5, 1884.
		(Doubtful cases.)
Frisac,	Recovery,	Otis, op. cit.
Bouisson,	do.	Ibid.
Garcia,	do.	Ibid.
New,	do.	Ibid.
Ewing,	do.	Ibid.

Of the 13 cases of undoubted authenticity above tabulated, 10 are known to have been successful, and an eleventh (Félizet's) would have been equally so, but for imprudence in diet on the part of the patient.]

Foreign Bodies in the Intestines.—Foreign bodies may enter the bowel in the following ways:—

1. They may be swallowed and passed on through the pylorus. It is rare for bodies which have reached the gut in this way to become lodged within it, but it occasionally happens. Reference has already been made to a case in which the handle of a knife, seven inches long, passed into the duodenum and caused sloughing of its front wall. There are not a few instances on record in which fruit-stones have become impacted in the cæcal appendix. Fish-bones and particles of chicken and other bones become impacted in the walls of the bowel, and there set up abscess. I saw the late Mr. De Morgan remove a slender piece of bone from a fistula in ano which he was laying open; the evidence went to show that it had been swallowed, not introduced from below. Again, things like wool, hair, husks of oats, cocoanut-fibre, etc., swallowed little by little, may in time accumulate in the bowel and cause obstruction.[1]

2. After ulceration, biliary calculi, pancreatic calculi, renal calculi, and hydatids from the kidney and other solid organs, may enter the bowel and either give rise to obstruction or be discharged *per anum*.

3. Foreign bodies are not infrequently introduced into the rectum by the patients themselves, and there become impacted, or penetrate the walls of the rectum and enter the bladder, vagina, peritoneal cavity, or some coil of bowel which has descended into the pelvis. It is possible that they may sometimes work upwards even as high as the cæcum.[2]

4. Bullets enter the intestine after penetrating the abdominal walls, but

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[1] Dr. Down, Trans. Path. Soc. Lond., 1867; Bryant, op. cit., 3d ed., vol. i. p. 616.

[2] Holmes, Principles and Practice of Surgery, 3d ed., p. 215. 1882.

they generally pass *per anum*, being seldom retained in the gut. Hennen records a typical case.[1]

The *subsequent careers* of foreign bodies which have entered the intestine are various. (1) They may remain without giving rise to any, or but slight if any, inconvenience. Mr. Marshall[2] has recorded a very remarkable case in which a pound of pins was found in the duodenum, and nine ounces in the stomach, of a woman who during life had experienced attacks of gastric irritation. The pins had been accumulating at least five years, and at length the duodenum had become impassable.

(2) They may penetrate and be discharged through the abdominal walls, either after causing an abscess in the parietes, or after simply leading to adhesions between the bowel and parietal peritoneum. Poland mentions the case of a boy, aged 14, who had had scarlet fever and dropsy, followed by an abscess which burst at the umbilicus. A plum-stone escaped through the fistulous opening.

(3) They may pass *per anum*. Hager gives an instance of a young woman, aged 25, who vomited several pins, and passed several others with her stools. Mr. Callender[3] recorded a case of intestinal obstruction due to the impaction of a gall-stone. On the twelfth day of the symptoms the bowels acted spontaneously, and a calculus weighing 1 oz. 13 grs., and measuring 2 inches in length by 1½ inches in width, passed through the anus with some difficulty.

(4) They may penetrate or ulcerate through the walls of the bowel, and escape into the general cavity of the peritoneum, or into some other important viscus or structure, such as the vena cava or aorta.

(5) They may become impacted in the bowel and destroy life by intestinal obstruction; or, after months or years of pain and dyspepsia, by chronic ulceration of the gut set up by the foreign body as it gradually passes along the canal. A good instance of intestinal obstruction from gall-stone occurred in the Middlesex Hospital, and the specimen is in our museum. It consists of a portion of the middle of the ileum, with a large and almost spherical gall-stone nearly four inches in circumference; it has been sawn in half, and the upper fragment removed, and in this situation the mucous membrane of the intestine has ulcerated away, and above this the bowel is dilated and its peritoneal coat is partly covered by lymph. The gall-stone entered the duodenum through an ulcerated opening. The patient, a woman aged 46, died after ten days of vomiting and constipation.[4] Five cases of intestinal obstruction from gall-stone were collected by Marrotte, and communicated by him to the Medical Society of the Paris Hospitals, in 1856. Drs. Abercrombie and Oke[5] have reported three others, and Mr. Swaine and Mr. Appleton[6] have each recorded one case. In Mr. Swaine's, the calculus was impacted just above the ileo-cæcal valve. In Mr. Appleton's, there was an intussusception of the ileum just below the impacted calculus. Mr. Arthur E. Barker has recorded a very interesting case of death from intestinal obstruction, due to the impaction of a large biliary calculus in the upper part of the ileum, in front of the left iliac region. The stone was 4 inches by 4½ inches, and weighed over 5 drachms; and 14 or 15 other large biliary calculi were found in the intestines above the point of obstruction, and in the circumscribed, sloughing abscess-cavity which had been formed about, and which in large part had destroyed, the gall-bladder.[7] The gall-stones had entered the intes-

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[1] Op. cit., p. 408, Case LXV.

[2] Med.-Chir. Trans., vol. xxxv. p. 65.

[3] Trans. Clinical Soc., vol. vi. p. 193.

[4] For full report of case, by Dr. Vander Byl, see Trans. Path. Soc. Lond., vol. vii. p. 23.

[5] Brit. Med. Journ., May 20, 1853.

[6] Ibid., vol. i. 1857.

[7] Trans. Path. Soc. Lond., vol. xxix. p. 142.

tine through an opening on the right side of the second part of the duodenum. Langstaff relates the case of a mad-man who after swallowing a silver table-spoon began to suffer from dyspepsia, frequent and acute pain in the region of the cæcum and colon, diarrhœa, and the frequent discharge *per anum* of blood and pus. Ascites and other symptoms of diseased liver came on, and he was tapped; after this the spoon, which the patient had often said he could feel moving about, was detected in the situation of the cæcum through the abdominal parietes, but no attempt was made to remove it by enterotomy. The man died about twenty months after the tapping, and at the post-mortem examination the mucous membrane of the stomach, duodenum, jejunum, ileum, and cæcum, presented evident marks of ulceration at different points. The greatest mischief had been inflicted by the passage of the spoon through the ileo-cæcal orifice, which was much dilated; and the mucous membrane of the cæcum was nearly destroyed by ulceration. The spoon was found at this part, with the bowl downwards, having formed a large pouch which had checked its further progress. The preparation is in the Hunterian Museum.

Foreign bodies in the appendix vermiformis are by no means rare. Poland mentions the case of a girl, aged twelve, who after a few days of general weakness and loss of appetite was found dead in bed. There were extensive puriform peritonitis, and ulceration of the vermiform process, in which was found a small, leaden, foreign body making its way through. Dr. Peacock described at the London Medical Society the case of a clergyman, who, after symptoms simulating hernia, had an abscess form in the right iliac region, from which a cherry-stone came away. He died subsequently of some other disease.

Some years ago I saw, in the practice of my father, a young lady aged eighteen suffering from the most intense peritonitis, with symptoms suggestive of intestinal obstruction; she died, and on examination a damson-stone was found in the appendix cæci, the extremity of which was destroyed.

Foreign bodies other than those swallowed are at times found in the appendix, such as biliary concretions, and small, hardened masses of feces. All these cases for the most part end fatally, from acute suppurative peritonitis set up by ulceration and perforation of the coats of the appendix.

Foreign bodies are not often lodged in the *large bowel*, though they occasionally become impacted when introduced through the anus. There are, however, three conditions under which a foreign body which has passed through the length of the alimentary canal may become retained in the colon, sigmoid flexure, or rectum; these are (1) when solid fecal matter is deposited around the foreign body; (2) when owing to its shape the foreign body sticks into the wall of the gut, or becomes fixed across its lumen; and (3) when any constriction of the bowel exists, whether this be due to some form of stricture, or to adhesions, adventitious bands, pressure of a tumor, or other cause. Mr. Clement,[1] of Shewsbury, has recorded a case in point:—

> A lady who for fourteen days had suffered from complete constipation and the symptoms usually attendant on strangulated hernia, had her colon opened in the right loin. After recovery from the operation, a mass consisting of five plum-stones, agglutinated together, was shot out through the artificial anus. Subsequently, and at intervals, other plum-stones were discharged, until the total number amounted to 116. She died three years after the operation, and there was found at the junction of the ascending and transverse colon a most rigid stricture—not quite a quarter of an inch wide, perfectly smooth, and of pearly whiteness—looking just as if a piece of whipcord had been firmly tied around this part of the intestine. The stricture was of cartilaginous hardness, and the occlusion so complete that not even a bristle could be passed through it.

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[1] Med.-Chir. Trans., vol. xxxv.

Treatment.—Enterotomy should be performed if the foreign body becomes impacted, and life is threatened either from obstruction or perforation, or is rendered miserable and useless as the result of the foreign body's continued presence in the bowel; also if the foreign body be such as is not likely to pass the ileo-cæcal valve and cæcum, and especially if it be long and of angular shape.

In the American Journal of the Medical Sciences[1] is an account of an interesting case in which a silver spoon was successfully removed by enterotomy from the small intestine of a man aged twenty-six years, one calendar month after it had been swallowed; the intestine, after the extraction of the spoon, was sewn up and returned. The operation was performed on Aug. 7, 1806, by Dr. White, Senior, of Hudson, N. Y., who published an account of it in the Medical Repository.[2]

Mr. Bryant[3] relates a case of acute intestinal obstruction due to a gall-stone, which had entered the duodenum by ulceration of its coats. This stone, which weighed 238 grains and measured three and one-quarter inches in circumference, had become impacted in the ileum about a foot above the ileo-cæcal valve, and was removed by enterotomy by Mr. Bryant. Unfortunately the patient died from peritonitis, which had commenced before the operation was performed.

Enterotomy.—This operation consists in cutting through the abdominal parietes in the middle line, if the exact position of the foreign body is unknown, but along the linea semilunaris, or in one of the iliac regions, or at any other spot near to or over the foreign body, if it can be felt through the abdominal walls. The portion of intestine in which the foreign body is lodged should be drawn to the surface of the wound, and carefully surrounded with properly prepared sponges, so that nothing may escape from the incised gut into the peritoneal cavity. Next, the bowel should be opened by as small an incision as possible, and the foreign body removed by polypus or claw forceps, or with the finger and thumb. The wound in the gut is then to be sewn up by Lembert's, Jobert's, or the continuous suture. Finally, the gut should be returned into the abdomen, and the parietal wound closed by interrupted sutures of silk or fishing-gut, passed through all the layers of the abdominal walls, including the peritoneum. The wound should be dressed as after ovariotomy and gastrotomy, and the after-treatment should be the same. If the foreign body be impacted in the cæcum, the operation just described should be performed, the external incision being made in the right iliac region. In certain cases of impaction in the large intestine, *colotomy* will be indicated, and may be followed by the exit of the impacted substance, as well as by complete relief of the intestinal obstruction. Mr. Clement's case has been already cited to illustrate this fact. In June, 1880, M. Verneuil brought before the Society of Surgery, in Paris, the case of a man aged forty, who had introduced a piece of wood into his lower bowel to check diarrhœa. The foreign body, a few days afterwards, was above the reach of the hand in the rectum, so laparotomy in the median line was performed, and the foreign body was pushed downwards along the bowel until it could be seized in the rectum and withdrawn *per vias naturales.* The man recovered well. Hévin mentions an ingenious device which was resorted to by Marchetti. Some students had pushed a pig's tail, previously frozen hard and with the hair cut short, into the rectum of a lewd woman. The hairs sticking in the gut resisted all attempts at removal, until Marchetti introduced a hollow tube over the pig's tail, and brought the tube away with the tail included in it.

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[1] Loc. cit., July, 1876, p. 279.

[2] Loc. cit., Second Hexade, vol. iv. p. 367.

[3] Trans. Clin. Soc., vol. xii. p. 106.

LOOSE AND FOREIGN BODIES IN THE PERITONEUM.

Besides such morbid contents as blood and air, other substances are found free in the peritoneal cavity, such as gall-stones and intestinal concretions which have escaped by ulceration. These, however, when they do not cause fatal peritonitis, become encysted by adhesions, rather than continue quite free and unconfined in the cavity. Loose bodies, of size varying from that of a bean to that of a pigeon's egg, are occasionally met with in the general cavity of the peritoneum, and may be of several kinds: (1) Growths connected with the intestine by long, thread-like pedicles, or cast entirely off; (2) appendices epiploicæ, as pointed out by Mr. Shaw; (3) loose earthy and calcareous bodies, probably detached and degenerate mesenteric glands, as in Case CCXXXI. given by Habershon; (4) coagula of blood, which after clotting have been organized into fibrinous masses; (5) detached uterine myomata;[1] (6) portions of large fatty tumors, which have undergone fibrous and osseous transformation, and have then become separated from the original mass.[2] Such loose bodies may get into a hernial sac and give rise to symptoms of hernia.

Foreign bodies introduced from without, sometimes lodge a long time in the peritoneum. One of the most extraordinary cases of this sort has quite recently been recorded by Thorndike:—[3]

A sailor, aged 41, was in the habit of pushing an 8-ounce bottle into the rectum to overcome retention of urine due to spasm. On one occasion, not having a bottle, he introduced a pebble 5 inches by 3 inches in magnitude; the stone slipped up beyond the sphincter; the captain's boy tried to remove it by pushing his hand up after it "as high as the shoulder;" two days afterwards laparotomy along the outer border of the left rectus was performed, and the stone, which was found lying among the intestines just below the stomach, was removed. The patient made a good recovery.

ABDOMINAL ABSCESSES.

Abdominal abscesses are of four kinds: (1) Those between, and on the exterior of, the viscera of the abdomen; these are often, but by no means always, the consequence of abdominal injuries which have given rise to localized peritonitis. (2) Visceral abscesses, or those which have originated in, and, for a time at least if not throughout the whole of their course, are confined to, the interior of some one organ; such are the hepatic, splenic, renal, omental, and biliary abscesses. (3) Parietal abscesses, or those which occur from various causes between the layers of the abdominal parietes. (4) Retro-peritoneal abscesses. The last two varieties having been already considered, we have now to describe only the first two.

PERITONEAL ABSCESSES are of two kinds, the circumscribed and the diffused.

1. The *abscesses which are exterior to the organs, and yet circumscribed*, occur in all parts of the abdominal and pelvic cavities, and are walled in by fibrinous adhesions between viscera and parietes, or between two or more of the viscera, or two or more coils of the intestine. Such cases are of great interest and importance in regard to both diagnosis and treatment; but they vary so greatly from one another in their symptoms, course, and pathological

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[1] Eve, Trans. Path. Soc. Lond., vol. xxxi. p. 316.

[2] Dreschfeld, ibid., vol. xxxi. p. 287.

[3] Medical and Surgical Reports of the Boston City Hospital, 3d series, 1882.

anatomy, that it is to a great extent impossible to group them, and each seems to stand aloof from the others, as an isolated, or at any rate as an exceptional condition. On this account, and because too, as Dr. Fagge[1] has remarked, they do not yield specimens which can be shown to advantage at a Pathological Society, they have not succeeded in gaining for themselves a place in systematic works on medicine or surgery. It is well, therefore, to refer to them, since, doing so "must necessarily suggest to the mind of every reader, the important fact that in practice the abdomen may be found affected with other diseases besides those which are ordinarily enumerated under the heading of diagnosis in a treatise on medicine." (Fagge.)

Causes.—Peritonitis, which may even have been general, leads in some part of the abdominal cavity to a circumscribed collection of pus, and it is not always easy to say whether the peritonitis has been idiopathic, or due to some local cause, even though search be made after death.

Often, however, there is a definite history of a blow, kick, sprain, or other injury having excited the peritonitis, and in some cases it has been ascertained that the injury had ruptured some part of the abdominal organs.[2] In other cases, the peritonitis has followed some accident of parturition, and has left behind an abscess in some distant part of the abdomen; or an abscess in the left hypochondrium has resulted from a general puerperal peritonitis. (Fagge, Case II.) Other causes have been cancer of the stomach or intestines, simple and dysenteric ulcers of the gastro-intestinal tube, gall-stones, and various other conditions which have led to inflammation with adhesions, and then to suppuration of the surrounding or adjacent peritoneum. Sometimes a visceral abscess situated near the surface of the organ will give rise to a circumscribed peritoneal abscess. I have before me now the post-mortem record of a case in the Middlesex Hospital, in which dysenteric ulceration of the colon had given rise to multiple hepatic abscesses, mostly near the surface of the liver, these in turn having caused a large circumscribed peri-hepatic abscess between the diaphragm and liver, the convex surface of which organ had been so pressed upon by the outside abscess as to have become concave. Diseases connected with the appendix cæci,[3] the ovaries, uterus, bladder, or kidneys, are other exciting causes, and the abscesses thus excited may or may not open into the colon, rectum, sigmoid flexure, cæcum, vagina, or bladder. I have repeatedly had under my care patients with uterine cancer, who, in the later stages of their illness, have suffered from peritonitic pain and tenderness, and from the formation of a prominent and hard tumor in the hypogastrium; at the post-mortem examination the uterus is found to have been more or less—sometimes entirely—removed by ulceration, when a large abscess-cavity, with stinking, ill-colored, turbid, fluid contents occupies its place. This offensive cavity is shut off from the general peritoneal cavity by coils of small intestine matted together, so as to form its roof. There is beside, in these cases, general peritonitis, and though, from the character of the matter, fecal extravasation is suggested, this is commonly demonstrated not to have been present. I am now quite alive to this condition, and should always suspect it in cases of uterine cancer where there has been much discharge, and where a hypogastric tumor, developing in the late stage, is attended by more or less constant abdominal pain and tenderness. Ovarian tumors of a non-malignant type sometimes co-exist with cancer of the uterus, but their characters are sufficiently distinct not to require to be diagnosed from the encysted abscesses referred to.

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[1] Cases of Abscess within the upper part of the Abdomen. Guy's Hospital Reports, 3d series, vol. xix. p. 213.

[2] See a case recorded by Mr. Cæsar Hawkins (Trans. Path. Soc. Lond., vol. i. p. 150), in which there were two circumscribed peritoneal abscesses, one fecal, and the other, in the left hypochondrium, communicating with an abscess in the left pleural cavity through a traumatic rupture of the diaphragm.

[3] See a case by Dr. F. Taylor, in Guy's Hosp. Reports, vol. xix. p. 266. Several circumscribed collections of pus were found within the peritoneal cavity, and due to this cause.

Course and Symptoms.—Circumscribed peritoneal abscesses may occur at any age, from childhood upwards; they may also occupy any part of the peritoneal cavity, and they are often multiple. Probably the commonest, and some of the most important cases, are those situated in the right and left hypochondria, that is, between the liver and the diaphragm, and between the spleen and stomach and the diaphragm. In the valuable article referred to, Dr. Fagge has described sixteen cases of this sort; in six the abscess was between the liver and the diaphragm, and in ten in the left hypochondrium. In five of the six supra-hepatic cases the pus was over the right lobe of the liver; in the other, the abscess was on the convex surface of the left lobe, and there was a perforation through the diaphragm into the left pleural cavity.

In a large proportion of hypochondrial abscesses, the corresponding side of the thorax becomes affected; pleurisy, pneumonia, pleuritic effusion, or empyema, results: and the case is very likely to be mistaken for one of thoraçic disease, whilst the abdominal abscess is overlooked. The course of such cases is frequently this: the liver or spleen is injured, perhaps ruptured, or perhaps the capsule is stretched, not actually torn; this is followed by local peritonitis terminating in abscess beneath the diaphragm; then pleurisy is set up, followed by adhesion of the base of the lung to the diaphragm, and, inflammation spreading, effusion takes place, and the lung is compressed against the spine by the increasing effusion of serum; at a later period the abscess bursts through the diaphragm, and opens into the adherent lung, or into the lung and pleural cavity as well, and then an empyema is established. If the abscess is on the left side, pericarditis as well as pleurisy may be excited. In cases in which cancer, ulcer, or any other pathological condition excites these sub-diaphragmatic or hypochondrial abscesses, the course of the case may be just the same as above described. In other cases, again, the abscess may discharge itself into the stomach or transverse colon, and air may enter the abscess from the bowel; when this happens in the left sub-diaphragmatic abscess, each beat of the heart may give a splashing sound, as in a case described by Fagge (Case VII.).

Sometimes an abscess will open at a number of different points into the gastro-intestinal tube:—

A woman, aged thirty-three, suffering from tubercular peritonitis, was under the care of Dr. Coupland, in the Middlesex Hospital, in November, 1880. She died, and at the post-mortem examination an abscess-cavity was found, containing fetid gas, and semi-purulent and partly feculent matter. The abscess was bounded in front by the posterior wall of the stomach, and below by the collapsed transverse colon and some coils of ileum; two perforations existed in the ileum, and three in the upper and anterior wall of the colon, within an area of two square inches; each of these openings was large enough to admit an ordinary cedar pencil, and all had clearly been formed by ulceration extending from the serous towards the mucous coats. In no other part of the intestine was there any ulceration of the mucous membrane. The stomach was inseparably adherent to the liver, spleen, colon, and parietes; and numerous opaque, flattened, tubercular nodules studded the peritoneum. There was no fluid in the general peritoneal cavity.

The symptoms of circumscribed peritoneal abscesses so vary with the cause and condition of the patient, that it is not possible to mention definitely any which are common to all cases. Probably, though by no means certainly, there will be evidence of severe inflammation, with rigors, following an injury; or coming on in the course of some illness connected with one or other of the abdominal organs. There will be high fever, local tenderness, and increased dulness on percussion, and in a short time a tumor may show itself. Sometimes the swelling is visible below the edges of the lower ribs, sometimes in the epigastrium, or in the lumbar region. In not a few cases there have been intermittent attacks of severe abdominal pain, tenderness, and tympanites, attended with general symptoms of fever or of aguish attacks; dyspepsia, provoked by the implication of the sympathetic nerves and ganglia in the surrounding inflammation; constipation and sickness; and sometimes vomiting of blood-stained fluid or of blood.

Such symptoms, occurring after a period of some abdominal ailment, or of fixed abdominal pain of long duration—or themselves extending over many weeks or months, or perhaps recurring at intervals during a year or two—should make the surgeon suspicious that abdominal abscess exists somewhere, though there may be nothing to point definitely to the seat of the mischief, and though, too often, surgical aid could not avail if an exact diagnosis were formed. Much the same sort of symptoms are caused by retro-peritoneal abscesses, and in some cases, such as those in which suppuration is excited by ulcers of the duodenum, strictures of the œsophagus near the stomach, pancreatic calculi, etc.—in which tactile and ocular demonstrations are not possible—it is quite out of the question to be able to say whether the abscess is behind or within the peritoneum, or both. In many respects, some of the abscesses between the diaphragm and liver resemble hepatic abscesses, and those between the diaphragm and spleen resemble splenic abscesses.

Diagnosis.—From retro-peritoneal and perinephric abscesses, from hepatic, splenic, and renal abscesses, from hydronephrosis, abdominal cysts, aneurisms, accumulations of extravasated blood, and malignant and other tumors, these intra-peritoneal abscesses have to be distinguished. Sometimes, in the diaphragmatic abscesses, the chest symptoms, after the first few days, altogether overshadow the abdominal, and thus lead to errors in diagnosis; even on post-mortem examination, there is occasionally room for difference of opinion as to whether such an abscess has caused empyema, or an empyema the abscess; in other cases it is quite as difficult to decide whether an abscess has been peri-hepatic or peri-splenic in its origin, and has involved the viscus in its progress, or whether its starting-point has not been in the substance of the organ. C. Zuber[1] reports two cases of peri-splenic collection, one of which had not been detected during life as there were no symptoms pointing attention to the left side, while the other was wrongly diagnosed to be a case of intra-abdominal malignant disease. Neither the error in diagnosis nor the post-mortem surprise is a very rare thing in such cases.

Attention must therefore be given to the previous history, onset, and earlier symptoms of these obscure cases; and if it be borne in mind that they very frequently, perhaps generally, result from direct external injury, or by extension from some disease in a neighboring organ, a correct diagnosis may often be made. The character of the tumor, when one exists, is not specially diagnostic; it is often a hard swelling or a mere fulness, the borders of which are rounded and ill-defined, and inclined away from the surface; on percussion it gives a note of a doubtful kind—sometimes dull, sometimes half tympanitic and half dull—and if there is a communication between it and the stomach or bowel, a peculiar gurgling sound may be detected in it. It must further be borne in mind, whilst examining a doubtful case of abdominal disease or tumor, that the liver, spleen, or other organ, may be displaced by the pus of a circumscribed abscess.

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[1] Rev. de Médecine, Nov. 1882.

The *prognosis* is unfavorable in most cases, and unless early relief be afforded by aspirating or opening the abscess, or by its spontaneous rupture into the stomach or intestine. When the abscess is caused by tubercular peritonitis, or by malignant disease of the ovary, uterus, or bladder, there can be no prospect of recovery, and the abscess must be regarded as a mere accident in the course of the original disease. In sub-diaphragmatic abscess, if early exit be not given to the pus, there is great risk of the diaphragm being perforated, and of those secondary changes occurring in the thorax which tend so rapidly and surely to a fatal issue. Death occurs in some peritoneal abscesses suddenly, from rupture into the general peritoneal cavity; in others, after a fortnight or three weeks, from the intensity of the inflammation; and in others, again, after a tedious illness of twelve months or more, from pyæmia, hectic, or exhaustion.

Treatment.—This follows on the same lines as the treatment of other abdominal inflammations, until pus is suspected or detected, when it should be searched for, and evacuated by the aspirator or trocar. Where a tumor presents itself, or if the hypochondrium is bulged, an incision should take the place of tapping, and the edges of the opening should be kept apart by a drainage tube. Care must, of course, be taken to avoid wounding any of the viscera limiting the abscess space. In an interesting case, reported by Dr. Frederick Taylor,[1] of sub-diaphragmatic abscess, attended with effusion into the pleura, the trocar was employed; but it was found after death that the instrument had passed below the pleuritic effusion, into the lower lobe of the right lung—which was adherent to the diaphragm—but not low enough to reach the abscess. In other cases an abscess between the diaphragm and liver has been reached through the wedge-shaped, lower edge of the right lung —the lung having become adherent to the parts around; and as a sinus, limited by inflammatory material, has subsequently formed, the abscess has discharged itself through the lung without communicating with the pleural cavity, or further implicating lung tissue. This, however, is a condition which cannot be reckoned upon, though it is well known to occur occasionally. In cases where the abscess has pushed the diaphragm and lung far up, the pus may be evacuated by an incision in the seventh or eighth intercostal space, without injuring the lung or opening the general cavity of the pleura. Small hope of good accruing from puncture can be entertained if the abscess have already burst through the diaphragm, into either lung or pleural cavity, and death must be all but inevitable if it have burst into the general cavity of the peritoneum. The *vis medicatrix naturæ* is only too frequently the motto of the fool's paradise, and, as far as the patient is concerned, another term for death. Nature does not select the bowel or the stomach more frequently, if as frequently, as some more dangerous channel through which to evacuate these abscesses; and, therefore, in all cases in which the cavity can be reached and drained, operative treatment is the best, and the sooner it is adopted the better. Sometimes a mistake in diagnosis has happily led to these abscesses being opened, and the patients' lives being thus saved. A good case is reported in the Glasgow Medical Journal for April, 1876:—

> A woman, aged 58, supposed to be suffering from ovarian disease requiring ovariotomy, was operated upon by Dr. E. Watson. On cutting through the abdominal parietes in the median line, about six quarts of thick pus escaped, and the finger passed into a cavity, in the lower part of which the organs of the pelvis were felt covered with

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[1] Case of Abscess between the Diaphragm and Liver. Guy's Hosp. Reports, third series, vol. xix. p. 257.

flocculent lymph, while above, the wall of the abscess formed a complete partition between its cavity and the intestines. No foreign substance was found in the pus. A drainage-tube was kept in the abscess for a time. The patient made a good recovery.

2. *Diffused Abscess of the Peritoneum.*—As distinct from the circumscribed peritoneal abscesses just described, though sometimes associated with them, there is a form of suppurative peritonitis in which the whole of the peritoneum is involved, and in which, therefore, the abscess-cavity and the peritoneal cavity are one and the same.

Causes.—The cause of the suppuration is generally obscure, and certainly by no means always due to tubercular disease of the peritoneum. It has been known to follow typhoid and recurrent fever, chicken-pox, and exposure to damp and cold; and, again, it has come on without any known cause. It has sometimes been associated with suppurating mesenteric lymphatic glands; and in a case of suppurative peritonitis, in a man aged 31, upon whom I performed laparotomy in the middle line, I believe this to have been the cause of the disease. It is probable that the immediate cause of this form of exudative peritonitis is frequently a thrombus.

Symptoms.—After a period of perhaps severe but ill-defined illness, with symptoms suggestive of some abdominal disease, the abdomen will become irregularly swollen, of peculiar shape, and bulging prominently in the umbilical, hypogastric, or epigastric region, or on one side of the middle line, and towards the lumbar or iliac region. There will be dulness on percussion and tenderness on pressure, and subsequently a thrill will be detected in the prominent part. The temperature will vary, and will be generally found to rise to 101–103° F. in the afternoon or evening. Possibly the symptoms will have been ushered in with shivering and vomiting. There may then be the appearance of an abscess forming in the abdominal parietes, which may burst spontaneously; or, what is more likely, fluid will be suspected, an aspirating needle will be introduced, and some, and possibly very fetid, pus will escape.

If the pus is spontaneously discharged, it will most likely be at the umbilicus, and a fistulous opening will be left, through which a probe can be introduced into the general cavity of the peritoneum, and can be moved freely in every direction.

Course and Prognosis.—The chief danger in these cases is probably the liability of some of the pus becoming encysted between the diaphragm and liver, or diaphragm and spleen, and then taking the course of sub-diaphragmatic abscess—namely, perforating the diaphragm, and leading to death from empyema or suppuration in the lung. Or the pus may become encysted, and subsequently break into the bladder or rectum, and cause death by hectic or exhaustion; or a number of encysted collections of pus may be formed, separate and distinct from one another.

Dr. Goodhart,[1] to whom I am indebted for the narrative of three typical cases of diffused peritoneal abscess in children, had two recoveries and one death. One of the patients who recovered, was a girl, aged eleven, in whom an abscess burst at the umbilicus, eight weeks after she had fallen ill with typhoid fever. A sinus remained, and a copious purulent discharge continued for some months. There was a puffy fulness between the epigastrium and umbilicus, and great distension of the veins of the abdominal wall, but no fever whatever. Pus could be made to flow from the sinus by pressure upon every accessible part of the belly, and a probe passed inwards five or six inches, and moved freely in all directions. The other successful case was in a girl, aged five, whose illness had begun six weeks before with "inflammation of the bowels." She was sent into hospital for supposed retention of urine; the abdomen was bulged "like the abdomen of pregnancy in miniature." An exploratory syringe, introduced two inches below the umbilicus, withdrew some thick, dirty-looking and fetid pus; two days afterwards a free incision was made antiseptically in the median line, and ten ounces of pus and very fetid gas were let out. A drainage-tube was retained for a few days; in a short time the discharge ceased; and by the end of six weeks the wound had quite healed. The third and only fatal case occurred in a boy, aged eleven; the pus was evacuated at the end of a month through a very small incision, which was afterwards enlarged, but death from double empyema and cheesy pneumonia followed three and a half months from the onset of his illness. At the post-mortem examination there was found general suppurative peritonitis; the coils of intestine were matted together, and there were three localized abscesses in the peritoneum: one led from the brim of the pelvis downwards between the rectum and bladder, into the ischio-rectal fossa; another lay between the liver and diaphragm, and had during life been opened through the latter by an incision in the eighth right costal interspace; and the third was between the spleen and diaphragm, and opened into the left pleura and lung. Such cases as the above are by no means peculiar to children, but occur in adults with perhaps equal frequency.

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[1] These cases have since been brought before the Clinical Society of London. See Lancet and Brit. Med. Journal, October 20, 1883.

The treatment consists, in the early stage, in allaying abdominal pain and tenderness by opium and hot fomentations, and in keeping up the strength of the patient by mild nutritive food, such as milk, light puddings, beef-tea, etc.

As soon as the presence of pus is ascertained, a free incision should be cautiously made into the abdomen along the median line, unless there is any indication for selecting some other part, such as marked fluctuation or prominence. A drainage-tube should be left in the wound, and if pus is found to bag in places, it should be removed at the time of operation by means of well-prepared carbolized sponges. Indeed the "toilette" of the peritoneum should be carefully attended to in these as in all other cases, but officious interference with adherent purulent lymph must be avoided, as likely to lead to troublesome capillary bleeding. Schmidt performed laparotomy for purulent peritonitis, on a patient aged twenty-one, in the Moscow Military Hospital, and with a good result. The abdomen was opened by an incision from the umbilicus to the symphysis, and on division of the thickened peritoneum a large quantity of healthy pus gushed out. Drainage-tubes were inserted, and the wound healed, recovery being complete in two months.[1]

VISCERAL ABSCESSES.—I. HEPATIC ABSCESS.—*Causes and Mode of Origin.*—Amongst the most important causes of liver-abscess, as far as the surgeon is concerned, are surgical operations and other injuries.

A contusion of the substance, unattended by laceration of the capsule of the gland, is a recoverable injury, but one prone to be followed by abscess.[2] Ruptures and penetrating wounds of the liver, if not fatal from hemorrhage, may excite abscess. A case in which a sabre-wound of the liver was followed by an abscess of that organ, with ultimate recovery, is recorded by Dr. Otis;[3] and Dr. Harley has published a case of recovery from hepatic abscess caused by a fall from a horse.[4] Dr. Maclean mentions a fatal case of hepatic abscess following a blow.[1] It has been supposed that fracture of the skull, from falling on the head, is especially liable to be followed by abscess of the liver; but the fact that falls from a height are prone to produce laceration or contusion of this, the heaviest and largest of the abdominal viscera,[2] probably furnishes an explanation of the association, if it exists. It is, however, very doubtful if hepatic abscess and cranial fracture are frequently found in the same person.[3]

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[1] Lond. Med. Record, June, 1882.

[2] Dupuytren, Leçons Orales de Clinique Chirurgicale, t. vi. p. 443; Lidell, Am. Journ. Med. Sciences, n. s. vol. liii. p. 340, Pollock, Article on Injuries of the Abdomen in Holmes's System of Surgery.

[3] Medical and Surgical History of the War of the Rebellion, Part II., Surg. Vol., p. 129.

[4] Trans. Clin. Society, vol. iv. p. 13. 1871.

Budd and Frerich may be referred to for instances of hepatic abscess following operations for hemorrhoids and fistula in ano, the cauterization of cancer of the rectum, and violence in reducing rectal prolapsus. I have twice seen a large abscess in the liver after lithotomy: both men were about the same age—between sixty and sixty-five years— both came from the same village in Sussex, both died on the same (fifteenth) day after the operation. In each there was a large, single abscess in the liver; and in one suppuration had extended along the pelvic cellular tissue and the inguinal canal, and had led to an abscess in the course of the spermatic cord which had been opened during life.

Abscesses from such causes follow phlebitis, and are due to the transference of septic matters from the seat of operation to the liver, where they give rise, first of all, to embolic foci, the starting-points of the abscess. They are anatomically explained by the communication of the veins of the rectum, prostate gland, etc., with the portal system, through the inferior mesenteric vein. Hepatic abscesses occur after amputations and compound fractures of the lower limbs; any suppurating surface or cavity, more especially if in connection with diseased bone, and any ulcer, may give rise to them; but in these cases the general circulation, not the portal system, is the channel of infection, and the liver is invaded through the hepatic artery. These are the typical pyæmic abscesses, varying in size from that of a millet-seed to that of an orange, and they are often associated with similar abscesses in other viscera. (See Plate II., Vol. I., page 210, *supra.*)

The Netley Museum contains a specimen of liver-abscess the size of a walnut, in which a discolored needle, swallowed two years before, was found. The abscess had drained away through an opening into the duodenum; the man died of phthisis. Other foreign bodies, such as lumbrici, have been known to cause hepatic abscess. In the Netley collection is a liver showing numerous small abscesses surrounding lumbrici, which had perforated the organ in all directions, after reaching it by travelling along the biliary ducts from the intestine. Again, hydatid cysts and other new growths in the liver give rise to suppuration around them, and then to secondary hepatic abscesses within the area of the hepatic veins.[4] Various ulcerated conditions of the stomach and bowels, but especially of the large bowel, are the cause of hepatic abscess: a case was in the Middlesex Hospital, in 1877, under care of Dr. Cayley, in which there were three abscesses, the size of oranges, or larger—two in the right and one in the left lobe of the liver. One of those in the right lobe communicated with a large sloughing cavity in the base of the right lung, and had been opened during life. There were several ulcers in the rectum, from one to two inches above the anus, which were regarded as syphilitic. In another case, in the Middlesex Hospital, in 1878, under care of Dr. Thompson, there were numerous ulcers in the colon, and sloughing of the appendix cæci. In each lobe of the liver there were several abscesses the size of walnuts; each contained a little yellow pus and some necrotic liver-tissue of a sulphur-yellow color. Associated with, and doubtless caused by, the hepatic abscesses, was a large, circumscribed, peritoneal abscess in the right hypochondrium. It was bounded on the outer side, and above, by the ribs from the sixth to the twelfth inclusive, and by the diaphragm; on the left, or inner side, by the right lobe of the liver, the right border of which was concave instead of convex, and of a slate-blue color; and below by the colon, which was adherent to the liver and the abdominal parietes. Posteriorly, the abscess reached back as far as the angles of the ribs. There was a distance of a hand's breadth between the right edge of the liver and the thoracic wall. The colon, at its hepatic flexure, communicated with the abscess through an aperture large enough to admit the index finger. The abscess-cavity, which contained fetid gas and a dirty purulent fluid of a faint fecal odor, had been opened during life through a free incision in the sixth interspace. The lining membrane of the outer wall of the abscess was everywhere in a gangrenous condition. I might refer to other cases in which ulceration or sloughing of the cæcal appendix was found with abscess of the liver, and Dr. Goodhart tells me that his experience at the post-mortem room of Guy's Hospital leads him to regard disease of this appendix as a by no means unfrequent cause of hepatic abscess. Cases supporting this view have been recorded by Dr. Carrington.[1] The frequent association of hepatic abscess and dysenteric ulceration is well known, but their exact relationship is still a subject of dispute. There are good grounds, however, for believing in the occurrence of a form of hepatic abscess—the tropical abscess—due to suppurative inflammation of the liver and quite independent of dysentery, of every source of suppuration or ulceration, and of operation wound or other injury; and though it may coexist with or follow dysentery, it is but an effect, like the dysentery itself, of climacteric causes. Such is the opinion of Murchison, Sir J. Fayrer,[2] and others; and such the writings and statistics of Waring, Morehead, Macpherson, Maclean, and others, go to prove. Budd and others have, however, thought differently, and Dr. Dickinson[3] has recently pointed out some objections to this view.

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[1] Reynolds's System of Medicine, vol. iii. p. 322.

[2] Richerand, Nosographie Chirurgicale, t. ii. p. 244.

[3] Jones and Sieveking, Manual of Pathological Anatomy, edited by Payne, p. 620; also Ziemssen's Cyclopædia of Practical Medicine, vol. ix. p. 106.

[4] Cornil and Ranvier, Manual of Pathological Histology, page 901.

Accepting the teaching of Murchison and Fayrer, as to tropical abscess, we recognize three forms of hepatic suppuration: 1, The traumatic abscess; 2, The large, single, so called, tropical abscess, which, like the traumatic, is a local affection, though it may and often does coexist with dysentery; 3, The infective abscess; namely, that due to septic matter, whether derived from a dysenteric, syphilitic, or simple ulcer of the bowel, or from any other source within the patient, and whether the septic matter is conveyed to the liver through the portal veins, the hepatic artery, the hepatic veins, or the lymphatics.

Character and Size of Hepatic Abscesses.—Hepatic abscesses may be single or multiple, superficial or deep, encysted or quite undefined, with ragged and shreddy margins. The pus varies in quantity from a drachm or two to a gallon; and in color, consistence, and odor, it presents infinite varieties. It is frequently laudable, but may be greenish, brownish, reddish, or yellow, and sometimes it is mixed with sloughy shreds of liver-substance. A very good illustration of the large single abscess was seen in the case of a man, aged 35, with bronzed skin and hair like a mulatto, who was under Dr. Greenhow's care, in 1879:—

The lower ribs bulged, and dulness on percussion reached as high as the fourth rib in front. An incision through the seventh intercostal space was followed by the discharge of between 80 and 90 ounces of thick, dirty, brownish-green, but not offensive pus. On post-mortem examination, the lower lobe of the right lung was found adherent by recent lymph to the upper surface of the diaphragm. Fully three-quarters of the liver-substance was replaced by the abscess sac, which was bounded by liver-substance below and posteriorly, but above and in front, and also at the sides, by little else than the diaphragm and thickened liver-capsule. In front, the sac wall was particularly thin. After the evacuation of its fluid contents, the abscess-cavity still held some tenacious, solid masses, which adhered to the lining membrane, were greenish in color, and floated out in long shreds, like muco-pus, but were not of the nature of sloughs. There was great compensating enlargement of the left lobe of the liver; the spleen was enlarged and indurated, the kidneys were granular, and a quantity of ascitic fluid occupied the abdominal cavity.

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[1] Guy's Hosp. Reports, 3d ser., vol. xxvi.

[2] On Dysentery and Liver Abscess. Lancet, May 19, 1883.

[3] Trans. Path. Soc. Lond., vol. xxxii. p. 130. 1881.

Symptoms.—Liver-abscess is a disease of adult life, and is more especially common in tropical and malarial districts. Very extensive suppuration may be going on in the liver without giving any sign of its existence, either to the patient or to his medical attendant. The reason of this is, that the liver is not a sensitive organ, and that if the abscess is deep seated it may attain to serious dimensions before exciting peritoneal inflammation and pain. If the abscess is stoutly encysted, it may remain, perhaps, for years, and produce little or no constitutional disturbance. All writers with experience in tropical diseases, record cases in which persons, apparently in average health, have died suddenly from the bursting of an old and "silent" abscess. In malarial districts, and in Europeans debilitated from long residence in a tropical climate, the symptoms are obscure and insidious.

On the other hand, a small abscess near the surface will cause severe pain in the region of the liver, immediate elevation of temperature by two or three degrees, and a rise in frequency with increased sharpness of the pulse. If the abscess is situated near the upper surface, there will be a short, dry cough, often preceded, and for a while attended, by a friction-murmur at the base of the lung; whereas, if it be on the under surface, there will frequently be vomiting and other evidence of gastric or duodenal disturbance, or irritating diarrhœa, if the abscess is tending towards the colon, whilst if towards the outer aspect of the liver, there will be fulness, and perhaps fluctuation detected on careful manipulation. Non-encysted abscesses, even when deep-seated and of small size, are apt to excite fatal constitutional symptoms. In young persons not long resident in a hot climate, and especially if they have been living freely or intemperately, the constitutional symptoms are likely to be very severe.

The local symptoms are a sense of weight and fulness in the right hypochondrium, with inability to lie upon the right side; frequent spasmodic contraction of the rectus abdominis; and tenderness on pressure over the upper and right parts of the belly; occasionally fluctuation can be detected. The complexion is muddy and the countenance anxious; the tongue is thickly coated with a gray or yellow fur; and when suppuration commences, which in acute cases it does in from seven to twelve days, the patient emaciates, grows hectic, and has night-sweats. Rigors are of great significance when they occur, but are by no means constant; and both rigors and night-sweats are less marked in tropical than in infective abscesses. Slight jaundice often exists in the infective or pyæmic cases, and is due to the morbid condition of the blood from septic infection; but marked jaundice, excepting when the abscess arises from obstruction and ulceration of the bile-ducts, is very rare indeed. It seems to be an accepted dogma that when dysentery is complicated with hepatic abscess, ipecacuanha, so frequently prescribed for the dysentery, cannot be tolerated by the system.

Diagnosis.—A disease to some extent resembling, and often confounded with, abscess of the liver, is inflammation of the liver-capsule, known as perihepatitis. It occurs both idiopathically and secondarily, by extension of inflammation to the capsule in cases of hepatitis and hepatic abscess; and it is very important, owing to the requisite difference of treatment, to distinguish the idiopathic form from that which is a consequence of abscess. Idiopathic perihepatitis simulates pleurisy more than liver-abscess, and, unlike the secondary form, it is not preceded for many days by the symptoms of abscess—viz., loss of appetite, a feeling of malaise, with perhaps rigors and faintness, and some general fulness in the hepatic region. Moreover, acute perihepatitis is an illness of days, but one giving rise to sharp pain, febrile excitement, and local tenderness; whereas liver-abscess, though it is often attended by very ill-defined signs, is generally the cause of impaired general health, with a pale, muddy countenance, for a long time antecedent to the development of acute symptoms.

Hepatic abscess seems to have been confounded with distended gall-bladder, with cancer, and with hydatid cyst of the liver; but careful palpation and percussion, with due regard to the clinical history of the patient, ought to prevent these mistakes. It must be remembered, however, that hydatid cysts suppurate, and also give rise to suppuration around their walls. Pneumonia and pleurisy of the base of the lung will generally be distinguished by their physical signs on auscultation.

The *prognosis* is unfavorable, and especially so if the abscess be of septic origin. Complete recovery may, however, take place if the pus finds an exit, even though the discharge continue for many months. How much fatigue and exertion a person may endure when the subject of hepatic abscess, and yet recover, after endless journeying and deprivation, is shown by a very interesting case described by Sir J. Fayrer.[1] It is supposed that the pus is sometimes absorbed, but this is doubtful. An important element in the prognosis is the point at which the abscess is likely to burst; if rupture take place into the pericardium or peritoneum, death is certain; if into the pleural sac, the result is nearly always fatal; abscesses which point outwardly at an intercostal space are also unfavorable, but those which burst in the epigastrium are much less so. Morehead, Maclean, and Macpherson agree in this. Those which open into the stomach, intestine, or lung, are the most favorable. Dr. Harley[2] records a recovery from traumatic abscess, which he believes ruptured into the sac of the small omentum, and thence into the colon. Senac[3] states that he has seen an abscess partially penetrate the diaphragm and then burrow beneath the pleura, without getting into the chest. Occasionally one and the same abscess opens by several apertures. If more than one abscess exists the prognosis is very unfavorable; this condition may be suspected if improvement does not take place after evacuation of an abscess. If from the position of the aperture the abscess can not empty itself, hectic, and then death, are only matters of time. The disease sometimes proves fatal even before the pus is evacuated.

Treatment.—When pus has once formed, bleeding, the administration of mercury, and other antiphlogistic measures which are so valuable in idiopathic perihepatitis, are worse than useless. The strength of the patient must be kept up by use of the mineral acids, tonics, nourishment, and wine. Hot fomentations to the abdomen give great relief, and so do leeches, when the general condition of the system does not contra-indicate their employment. Opium is generally requisite to ease pain, or at least uneasiness, and to procure sleep. As soon as fluctuation is detected, the aspirating syringe, adapted to a good-sized trocar and canula, should be used, and the canula should be left in for some days. Sir J. Fayrer has devised a grooved trocar and canula which is introduced in the ordinary way; if after withdrawing as much of the pus as will flow through the canula, it be thought desirable to make an incision into the abscess cavity, a long straight bistoury can be run along the groove of the canula, which thus serves as a director for the knife. In many cases it is preferable to open the abscess by a free incision, and this should be made if possible below the ribs, and as near the xiphoid cartilage as the case permits. A drainage-tube should be used. The evacuation of the pus gives relief to urgent symptoms, but the prospect of permanent recovery is not very great. In cases of true infective origin, only temporary benefit, if any, can possibly accrue, and as the abscesses are small and often multiple, there is generally no use in attempting surgical treatment.

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[1] Lancet, May 19, 1883.

[2] Trans. Clin. Society, vol. iv.

[3] Traité de la structure du Cœur, etc., tome ii. p. 307.

In tropical abscess, change of climate often seems very beneficial, and a sea-voyage sometimes appears to work marvels. When a patient is suffering from a long-continued drain of pus, this resource should certainly be tried.

When fluctuation is not present, but the symptoms are urgent and the distress great, pus may be sought for with the aspirating needle.

With reference to the surgical treatment of hepatic abscess, hydatid cysts of the liver, and distended gall-bladder, much importance formerly was attached to the existence or non-existence of adhesions of the liver-cyst or gall-bladder to the abdominal wall prior to making an opening. Many surgeons considered it bad and dangerous practice to lay open these tumors until such adhesions had occurred, and various methods were employed with the view of securing their formation. An excellent and exhaustive account of these methods, and indeed of the whole subject of treating these collections of fluid, is to be found in Dr. Thomson's well-known work.[1] They may be briefly summarized as follows:—(1) Fixing the tumor by strips of adhesive plaster, applied over the abdomen before inserting even a fine trocar and canula. (2) Method of Graves, viz., to divide all the tissues to within a few lines of the peritoneum, and then stuff the wound with lint. The inflammation which follows is supposed to have the double advantage (*a*) of establishing adhesions, and (*b*) of determining the abscess towards this point. (3) Method of Bégin; an incision should be made down to the peritoneum, and this membrane should be raised with a pair of forceps and divided as if it were a hernial sac. If then it be found that the sac of the abscess, or cyst, be adherent to the parietes, it should be opened at once; if not adherent, by applying simple dressing to the wound for a few days, adhesions will take place, and the opening may be made as soon as adhesion is accomplished.[2] (4) Method of Récamier; this consisted in the application of caustic potassa to the skin over the swelling. The eschar which resulted was divided with a bistoury, and more caustic potassa was applied to the wound. This process was repeated until the caustic had caused firm adhesion of the two layers of the peritoneum, and then the abscess was opened with a trocar or bistoury.

The surgeons of to-day will, I think, endorse the conclusions expressed by Dr. Murray,[3] who wrote in 1839: "I believe it is now the opinion of most, if not all, the queen's medical officers in this command, that the sooner an abscess in the liver is opened after its existence and site are ascertained, the better; and that there is neither much danger of effusion of matter into the cavity of the peritoneum, even when no adhesion exists between the liver and external parietes, nor of hemorrhage from cutting pretty deeply into the substance of the organ, unless the operator be so ignorant and rash as to plunge his trocar into the large vessels situated near to the backbone. Surely the earlier the abscess is punctured, the better the condition of the liver and of the patient's constitution to institute the desirable process of adhesive inflammation and cicatrization, and the less degree of collapse and recession of the viscus there is likely to be from the parts naturally in apposition to it."[1] Dr. Murray further was disposed to believe that puncturing the liver in hyperæmia, hypertrophy, or inflammatory enlargement, so that blood should be abstracted from it (as the natives of India do in cases of enlarged spleen) would not only be perfectly safe, but would be singularly advantageous. Dr. Murray opened many hepatic abscesses, where no adhesions existed between the liver and the parietes, and in a good many instances the patients recovered, and in none did any matter escape into the peritoneal cavity after the operation. The escape of matter seems to be prevented by the constant state of apposition of the viscera. (Thomson.) Baron Larrey thought very highly of the practice of opening hepatic abscesses, and speaks of having had from twelve to fifteen successful cases. Dr. James Clark, of Dominica, had eight successful cases out of thirteen.

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[1] Practical Treatise on the Diseases of the Liver and Biliary Passages, pp. 226 *et seq.* Edinburgh, 1841.

[2] Journ. Hebdom., 1830.

[3] Madras Quarterly Medical Journal, October, 1839.

Dr. Horner,[2] of Philadelphia, about the same time as Dr. Murray wrote, related a case of hepatic abscess in which tapping had been performed before adhesion to the side had occurred, in the following manner: "An incision was first made horizontally, in a line with the anterior end of the eighth rib on the right side, a little in front of its cartilage, and through the side of the abdomen, which brought the liver into view; the latter was seen to rise and fall with the diaphragm in respiration; moreover, a knife handle was introduced between the surface of the liver and of the contiguous parts of the abdomen, thus making clear the want of adhesion. In this dilemma, I determined to stitch the liver to the side, which was accompanied by a large crooked needle, armed with a ligature of kid-skin of bulk sufficient to fill up the hole made by the needle. One stitch was made in this way, parallel with the upper margin of the incision, at the distance of four lines from it, and another in the same manner below. The liver being thus fixed closely to the side, a trocar and canula were plunged into the abscess, and five gills of purulent matter were immediately discharged, to the great relief of the patient; the matter continued to flow during the night, so that three or four more gills were discharged. The operation being ended, a bandage was put around the abdomen, so as to keep its viscera as still as possible. The canula was left in for fifty-four hours, and then a piece of a flexible catheter was substituted, the abscess discharging all this time small quantities of pus and serum mixed." Adhesion took place and no peritonitis followed, but death from exhaustion occurred after some days.

The modern method of opening these abscesses, and cystic tumors, and distensions within the abdomen, is practically the same as Dr. Horner's, the only differences being in matters of detail, such as the character of the sutures, the exact lines of incision, and whether the fluid should be evacuated before or after the liver, or cyst-wall, is stitched to the abdominal parietes.

II. Biliary Abscess.—The gall-bladder may be the seat of suppuration, or an abscess may form at any part of the cystic, hepatic, or common bile-duct. These abscesses are generally the result of obstruction to the free passage of bile from simple or cancerous stricture of the duct, from biliary calculi, or from cancer or some other growth pressing upon the ducts.

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[1] See Thomson, op. cit., p. 232.

[2] Am. Journ. of Med. Sciences, old series, vol. xiv. p. 87.

(1) *Suppuration of the gall-bladder* is a consequence of irritation and over-distension, such as occurs when the common bile-duct, or, still more frequently, when the cystic duct, is obstructed.

Symptoms.—Enlargement from suppuration is characterized by a more or less pear-shaped and elastic, sometimes even fluctuating, swelling, projecting below the edge of the liver and in the normal situation of the gall-bladder. It is painful, and tender to the touch, and is accompanied by febrile symptoms, and frequently by rigors and night-sweats. If the cause of the inflammation is an obstruction in the cystic duct, there will not be jaundice, and the motions will contain bile; but if due to obstruction in the common bile-duct, there will be jaundice, and the motions will not be mixed with bile.

Sometimes there is the previous history of biliary colic, and after the abscess has discharged spontaneously, calculi may be passed at longer or shorter intervals through the fistulous track—their passage being attended by severe dragging pain around the opening, as well as by headache and occasional attacks of nausea or actual vomiting. The course of a case of abscess of the gall-bladder is commonly as follows: A patient, most likely a woman, but occasionally a man,[1] of or beyond middle age, suffers from one or more attacks of biliary colic, attended or not by jaundice and vomiting. Some time, it may be many months, after one of these attacks, which has lasted perhaps two or three weeks, persistent and gradually increasing pain, accompanied by fever and other constitutional disturbance, though perhaps not by jaundice, will be experienced in the region of the liver.

After a time an enlargement will be noticed in the right hypochondrium, and as it increases it will give a sense of fluctuation, and will present other signs of deep-seated abscess. Rigors and night-sweatings will accompany this condition, and soon, if relief be not given by surgical means, the abscess will burst externally through the parietes, somewhere in the neighborhood of the umbilicus, or internally into the colon, duodenum, or peritoneum. If externally, pus of a laudable character, or tinged with bile, will escape; all the severe symptoms will cease; and the patient will gradually recover. A fistula will for a time continue to discharge bile or pus, or pus and bile, and biliary calculi may work their way out or be removed. The opening is generally to the right of and above the umbilicus, over the fundus or body of the gall-bladder, but it may be at or below the umbilicus, and even at a considerable distance from the region of the gall-bladder, in which case the fistula is very tortuous. Possibly a second fistula will form a few weeks after the first; the length of time that the fistula will remain open differs very much in different cases, and has been already referred to under the heading of Biliary Fistulæ.

Diagnosis.—Suppuration of the gall-bladder sometimes presents all the characters of an hepatic abscess, especially of the large, single, tropical abscess. Even in shape and situation the one often resembles the other, and when this is so, a correct diagnosis can only be made by inquiring into the history of the case, and the previous residences of the patient. Such a tumor in a person who has never lived in a tropical or malarial climate, would most probably be an abscess of the gall-bladder, not of the liver. In other instances there is an appreciable difference between hepatic abscess and distension of the gall-bladder, as the tumor of the hepatic abscess is not well defined, but merges into the surrounding parts, and is very variable in its situation; but the swelling of the distended gall-bladder is circumscribed and distinct, and is always situated below the false ribs. The circumference of the fluctuating part of an hepatic abscess is always hard and swelled, whereas a distended gall-bladder is not generally surrounded by any degree of hardness or swelling, and fluctuation is as manifest at the circumference as at the centre.

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[1] Dr. Habershon records a typical case in a man (Guy's Hospital Reports, 3d Ser. vol. xvi. p. 420); Dr. Murchison gives a typical case in a woman (Clinical Lectures on Diseases of the Liver, p. 531).

Other forms of enlargement of the gall-bladder, as from bile, mucus, gall-stones, or cancer, are usually to be distinguished from cystic abscess by the absence of febrile disturbance, and by the less acute course of the local as well as of the general symptoms. These enlargements will be referred to again hereafter.

Prognosis.—Pyæmia and secondary abscesses of the liver are the most serious consequences. The fistula which results from the bursting of the sac will remain open an indefinite time, but may close, and sometimes quickly, if the cause of obstruction have been a calculus which has been discharged with the pus, or soon after the abscess has opened.

Treatment.—Rest is most important (1) to facilitate and promote adhesion of the inflamed gall-bladder to the parietal peritoneum; and (2) to avoid peritonitis becoming general, or even extending beyond the coats of the gall-bladder and the part of the parietes with which it is in contact. Any sudden or forcible movement might cause rupture of the inflamed, softened, and often fattily degenerated walls of the gall-bladder. Opium, leeches, and hot fomentations will be requisite to relieve pain. Cooling salines, and a light, nutritious diet must be given. As soon as suppuration has occurred, and the distended gall-bladder presents an abdominal swelling, the aid of the surgeon should be sought, and either an incision should be made down to the tumor, or the abscess should be opened by means of potassa fusa, introduced into the wound after incising the skin, fascia, and part of the thickness of the muscular parietes. Opening the gall-bladder directly by an incision, is the better practice; and in doing this it is advisable, after exposing the surface of the cyst, to empty it of its fluid contents by an aspirator, before cutting through its coats. By means of two pairs of spring forceps the gall-bladder should be drawn up into the wound; and when flaccid, its wall should be incised with scissors or a scalpel; the aspirating canula being thus liberated and removed, it remains only to stitch the edges of the divided gall-bladder to the edges of the wound in the abdominal wall. As these abscesses are nearly always due to biliary calculi, there is no use in simply aspirating the tumor, and thereby leaving the cause of the suppuration behind, without providing an exit for fresh-formed pus; nor is there much hope that the fistula which results from spontaneous external opening will give room, or be direct enough in its course, for the escape of the calculi. Such may be the case, or the evacuation of the pent-up pus may so change the line or surroundings of the duct as to allow of the stone passing into the bowel, or the stone may ulcerate into the duodenum or colon. But these are contingencies which cannot be relied upon, and in the mean while delay may result in the rupture of the abscess into the peritoneum.

An incision properly planned and performed, not only provides for the immediate evacuation of the pus, but allows of the efficient drainage of the abscess-sac, and of the removal of any calculi which may be in the gall-bladder, or in the duct within reach from the wound, either at the time of the operation or subsequent to it.

(2) *Abscess in the Biliary Ducts.*—Calculi may give rise to abscess in the ducts at any point at which they become impacted, or excite inflammation. If the calculus does not escape or become encysted, suppuration and abscess will occur. Sometimes a calculus impacted in a duct excites an abscess in the adjacent liver-tissue, and after a time the calculus may pass from the duct into the abscess-cavity thus formed; or inflammatory adhesions may form between the inflamed duct and the neighboring structures, and the calculus then pass into a circumscribed peritoneal abscess; or it may ulcerate through

the coats of the stomach or some part of the bowel, most frequently the duodenum, and so give rise to an intestinal or gastric biliary fistula.

The very small concretions constituting "biliary gravel," which are formed in the radicles of the hepatic duct in the interior of the liver, may induce partial obstruction of bile and dilatation of the ducts—in some instances becoming inclosed in firm fibrous cysts, but in others causing ulceration of the ducts and multiple abscesses in the liver.

Symptoms.—The symptoms of these intra-hepatic duct-abscesses are very obscure. They do not cause jaundice, enlargement of the liver, or pain; but sometimes they give rise to a sense of weight about the liver, with colicky pains and occasional attacks of rigors, followed by heat and sweating as in ague.

The extra-hepatic duct-abscesses give rise to biliary colic, tenderness in the hepatic region, and vomiting or intestinal disturbance; and if the abscess be in the common duct, there will almost certainly be jaundice from biliary obstruction, and the liver will be swollen and tender.

Treatment must be directed to the alleviation of pain, the abatement of inflammatory symptoms, and the removal of the obstruction, if possible, by the use of non-depressing emetics. It will be seldom, if ever, that surgical treatment will either be indicated or advisable.

III. Abscess of the spleen is rare. It results occasionally from primary inflammation of the spleen, and is thus sometimes a consequence of injury, whether contusion or rupture. More frequently, however, it arises from inflammation secondary to some form of blood-poisoning, and it is then generally of embolic origin, the abscess being indeed a suppurating infarction; such are the cases which are caused by ulcerative endocarditis, wounds, surgical operations, and other exciting causes of pyæmia.

In other cases, splenic abscess is the result of phlebitis of the branches of the splenic vein. Diffused splenic suppuration is occasionally seen as a sequel of fevers. Suppurating hydatid cysts also lead to encysted abscesses, and sometimes to suppuration in the splenic tissue around the cysts. The spleen is sometimes involved in suppuration by extension of peritoneal abscesses, especially of those which are circumscribed, and which occupy the left hypochondrium.

Mr. Holmes[1] states that abscess of the spleen occurred in only one of six cases of pyæmia from necrosis of the tibia. In each of the six cases there was abscess of the kidney. Suppurating infarctions are generally well defined, and occur near the periphery of the organ; they are wedge-shaped, with the base towards the surface and the apex towards the interior; they vary in size from that of a pea to that of a hen's egg, or even much larger; and there are often two, four, six, or more foci present in the same spleen. If the separate abscesses break into each other, they may form one large cavity, containing pus and fragments of gangrenous or necrotic tissue, and occupying one-third or one-half the spleen; or even the whole spleen may be destroyed.

Results.—Splenic abscesses discharge (1) into the stomach or colon, (2) into the left pleural cavity, (3) into the peritoneum. In the latter event it may be the general cavity of the peritoneum into which the abscess opens, but what is perhaps more frequent is for the pus to become inclosed by inflammatory, fibrinous adhesions between the diaphragm and anterior parietes on the one side, and the stomach, colon, and small omentum on the other.

Symptoms.—The symptoms are in the first place those of inflammation of the spleen. Besides the general and constitutional signs, there are usually swelling, with tenderness and pain in the left side, and at a later stage possibly ascites or even general dropsy. Splenitis may however go on to suppuration without giving rise to any definite local symptom. In the later stages there may be hemorrhage from the intestine or stomach, as in other splenic affections.[1]

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[1] Trans. Path. Soc. Lond., vol. xiii. p. 188.

The *diagnosis* must be made from lardaceous disease and from Hodgkin's disease of the spleen, from malignant disease of the stomach and pancreas, from renal, supra-renal, omental, and left-side hepatic disease,[2] and from ovarian tumor. When the sharp anterior edge of the spleen, and especially when the notches in this edge, can be felt, any abdominal enlargement springing from the left hypochondriac and lumbar regions, and below, will point to splenic enlargement, even though it extend beyond the linea alba on the right, and down to the pelvis. If the enlargement of the spleen have been preceded by pain and fever, and have been subsequently attended by rigors, night-sweats, and fluctuation, the presence of abscess may with some confidence be predicted.

Prognosis.—This is most unfavorable if the abscess arises from any infective cause. If the result of injury, recovery may follow the opening and drainage of the cavity.

The *treatment* of abscess of the spleen resembles that of abscess of the liver. When possible, the abscess should be laid open by an incision through the abdominal wall, and the cavity drained. This procedure should be conducted in the way that has been already described at page 1007. When the abscess is situated near to, or reaches as far as, the surface of the spleen, the symptoms will with more certainty point to the nature of the disease, and operative treatment, unless the abscess be due to septic infection, will be more hopeful.

When the abscess is in the centre of the spleen, the symptoms may be quite insufficient to arouse the faintest suspicion of its presence, as in the case of the gentleman described by Dr. Abercrombie; and in these cases operative measures would be complicated by uncertainty as to the situation, and even as to the presence of pus. If, however, a deep-seated abscess be detected, it should be emptied by a trocar and canula, after exposing the spleen through an abdominal opening; and the canula should be retained, or its place taken by a full-sized tube, such as a catheter, passed through the canula before its withdrawal.

IV. Abscess of the Pancreas.—Inflammation of the pancreas is not common, and abscess is but rarely met with. Various authors have however recorded cases. In some, only a portion, in others the whole of the gland-tissue has been found destroyed, and in the latter case the gland-capsule has become a mere membranous bag filled with pus. Portal saw two pounds of pus escape from such a sac. In some instances unchanged pancreatic tissue has been found floating in pus. Sometimes the pus is mixed with pancreatic juice, and is a clear, inodorous, yellowish fluid containing small curds. Sometimes it is grayish-white or greenish, and of a faint, mawkish smell. Occasionally it is very fetid. The capsule partakes in the inflammation, and becomes a good deal thickened. Or the suppurative process may involve the pancreas by invasion from without, and be but part of a circumscribed peritoneal abscess. The suppurative process commences in the interlobular cellular tissue, and a number of small punctiform abscesses form, which may increase and gradually coalesce.

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[1] Aitken, Practice of Medicine, vol. ii.

[2] See Dr. Habershon's case in Guy's Hospital Reports, 3d ser., vol. xviii. p. 383. The diagnosis of this case was obscure, and it was doubtful whether the abscess was in the kidney or in the spleen, or in the left lobe of the liver.

Causes.—Metastatic abscess of the pancreas has been recorded as following disease of the testicle, suppuration of the spermatic cord, and castration. Portal and Petit give examples of this, and Petit uses them as arguments against the application of the ligature in extirpation of the testicle. In such cases the immediate cause of the abscess is thrombosis. Pancreatic abscess has also been observed in puerperal peritonitis, and in the bodies of those who have died of ague. Wilks and Moxon speak of having met with suppuration of the pancreas in the later stages of typhoid fever, pus forming around the gland as well as within it, just in the same way as the salivary glands are affected after fevers.

A calculus impacted in the pancreatic duct may excite suppuration within the gland. Fournier has recorded the case of an enormous abscess in the head of the pancreas, filled with calculi and giving rise to a localized epigastric swelling. Dr. G. Woodruff Johnston,[1] in an elaborate paper on "Calculous Affections of the Pancreatic Ducts," refers to two other cases of suppuration from the presence of calculi, in one of which an abscess the size of a nut, in the centre of the gland, contained several calculi, and had discharged part of its contents into the stomach through a hole as large as the thumb.

The pancreas may also share in the suppuration of some neighboring part; a perforating ulcer of the stomach or duodenum, for example, may be the starting point of the disease in the pancreas; or a biliary calculus or some other morbid condition may give rise to a circumscribed peritoneal abscess, in which the pancreas subsequently becomes involved.

Symptoms.—These are sickness, vomiting of a clear greenish fluid, thirst, faintness, constipation, and epigastric distension accompanied by general feverishness, and afterwards, in all probability, by rigors and sweating. If the collection of pus be large, it may produce symptoms due to pressure on adjacent organs. If ulceration of the capsule occurs, the pus escapes into the stomach, duodenum, or other part of the intestine, or into the peritoneum; and pus will then be discharged through the mouth or anus, or fatal collapse will occur. Abscess of the pancreas has been known to cause, by its pressure, obliteration of the gall-ducts and of the pancreatic duct, and, as a result, pale and fatty stools have been voided; and the pancreatic vein or the pancreatico-duodenal artery[2] may possibly be destroyed by it, and then syncope and pallor of the surface, with the other evidences of internal hemorrhage, may be witnessed. Obscure symptoms of peritonitis may alone exist.

Abscess of the pancreas does perhaps occasionally dry up, and a white, amorphous mass is the only remains of the pus to be seen. Even when they run their course, these abscesses are but rarely if ever *diagnosed*, and if they be diagnosed, surgical *treatment* does not seem to offer any prospect of relief or cure. Measures directed to the relief of urgent symptoms alone appear to be available. If a localized swelling follow the symptoms of inflammation of the pancreas, the propriety of an abdominal exploration, followed up by the opening and drainage of the abscess, ought to be seriously considered.

V. Abscess in the Omentum and Mesentery.—An abscess sometimes forms within the substance of the mesentery, or within either the small or large omentum, as part of a general suppurative peritonitis, or in association with a circumscribed peritoneal abscess. Again, pus sometimes burrows or bursts into the sac of the omentum from a neighboring part or organ.

In the History of the War of the Rebellion,[3] mention is made of a shell-contusion of the abdomen, which was followed by sloughing of the abdominal walls and general suppurative peritonitis ; at the post-mortem examination the mesentery was found enormously thickened, its glands inflamed, and in it were large collections of black, fetid pus, which communicated with the sac of the peritoneum.

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[1] Amer. Journ. Med. Sciences, Oct. 1883, p. 421.

[2] See case by Dr. Norman Moore, Trans. Path. Soc. Lond., vol. xxxiii. p. 189.

[3] Op. cit.. Part II., Surg. Vol., p. 24.

Dr. Habershon[1] records a case of abscess of the lesser omentum lined by pyogenic membrane. The foramen of Winslow was closed, and the abscess-cavity was filled with brown, fetid contents. The omental abscess communicated with an abscess of the spleen through an opening about one inch in diameter at the posterior part of that organ. A hydatid tumor of the spleen had suppurated, and in addition to the abscesses of the spleen and omentum, it had led to the formation of a circumscribed peritoneal abscess.

A woman who was under my care in the Middlesex Hospital, with cancer of the uterus which had ulcerated into the bladder, died of very acute peritonitis. The cavity of the lesser omentum was distended with a thick, opaque, grayish fluid of purulent character.

Dr. J. Harley[2] relates a case in which he believes that an abscess of the left lobe of the liver burst into the omental sac, and then burrowed behind the peritoneum until it opened into the sigmoid flexure.

Mercklin described a case of abscess of the mesentery opposite a point in the right lumbar region which during life had been the seat of intense pain. In this abscess there were several calculi similar to one found in the pancreas itself; the inference is that the calculi in the mesentery had escaped by ulceration from the pancreas, and had given rise to the abscess in the mesentery.[3]

Symptoms.—The symptoms of mesenteric and omental abscess will be probably quite indistinguishable from those of severe peritonitis running on to circumscribed peritoneal abscess. Fever, restlessness, thirst, nausea, and abdominal pain and distension have been very marked in some cases, and syncope and other evidences of diaphragmatic and cardiac disturbances have been recorded in others.

Treatment.—In most cases the treatment can be only palliative and expectant, but when the signs of peritonitis are present, the ordinary treatment for that affection must be employed. As these abscesses are for the most part secondary, and due to the bursting of an abscess in a neighboring organ, or to the irritation of biliary or pancreatic calculi, or are the result of a general suppurative peritonitis, little permanent good can be expected from laparotomy and the evacuation of the pus. The procedure would, however, be worthy of trial in any case in which from the symptoms all hope was not utterly abandoned.

VI. PERINEPHRIC ABSCESS.—Either acute or chronic inflammation of the cellulo-adipose tissue about the kidney is very likely to end in suppuration.

Causes.—The various injuries to which this part of the body is liable, such as blows, strains, punctured and incised wounds, whether they involve the kidney or not, and whether urine is extravasated or not, are likely to excite perinephric abscess. Sometimes the exciting cause is a chill, especially after exposure to great heat, and after sweating ; it occurs during the course of, or as a sequel to, the continued fevers ; and it is often the consequence of extension of inflammation from other parts, namely, the pelvis, colon, testicle and spermatic cord, spleen, liver, gall-bladder, or vertebræ. It most frequently originates in suppurative pyelitis or nephritis, by extension through or actual perforation of the capsule—the kidney-affection in some cases being secondary to inflammation of the bladder, in others due to tubercle or calculus within the kidney. A renal calculus, after destroying to a greater or less extent the renal structures, may ulcerate through the capsule and lie loose in a suppurating space behind the kidney. Tuberculous matter may lead to ulceration of the capsule, and may sprout fungus-like into the tissue around the kidney; or perinephric abscess may be induced by it without its first perforating the renal capsule. Urethral stricture, vesical calculus, and disease of the prostate, may each lead to acute or chronic perinephritis. Evidence of chronic perinephritis is often seen in the post-mortem examination of such cases, and is furnished by the induration of the peri-renal cellular tissue and by the thickened and firmly fixed renal capsule which is left behind on attempting to remove the kidney. In acute cases, the capsule is found to be very vascular, and numerous abscesses are formed in the inflamed cellular tissue around the capsule. In time these abscesses coalesce, and burrow far and wide, if they do not soon open into the colon or at the loin. These abscesses may extend from the liver or spleen as low as the iliac fossa, and may at length protrude the abdominal walls, backwards, outwards, or towards the front. They occur commonly in adults, but as the result of injury they may arise at any age; though, perhaps, more frequent in men, they often are met with in women. Some few of these abscesses are quite simple in origin, course, and termination.

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[1] Guy's Hosp. Reports, 3d series, vol. xviii. p. 383.

[2] Trans. Clinical Society, vol. iv. p. 13.

[3] See Dr. G. Woodruff Johnston's paper, loc. cit.

In the 26 instances brought together by Dr. Duffin, of King's College Hospital, London, 2 were the result of severe injury to the loin; 2 had a puerperal origin; 1 followed a renal abscess secondary to lithotrity; 1 was excited by irritability of the bladder; 8 by kidney-disease; and in 12 the abscess appeared to have been independent of any affection of the urinary organs. In 5 of these 12 cases, a sprain of the loins seems to have been the exciting cause, in 3 exposure to cold, and in 1 the abscess was secondary to ulceration in the gall-bladder.

Symptoms.—The constitutional symptoms are the same as are excited by deep-seated abscesses in other regions, and will be more or less severe, according to the acuteness of the inflammation. Generally, they are well marked, but in old or weakly persons, and when the inflammation is chronic, they are masked, until the abscess by its size and pressure upon surrounding structures forces itself upon attention. A peculiar sort of lameness is often an early symptom, and is due to the flexed position in which the thigh of the affected side is retained in order to relieve pressure upon the inflamed structures. The sitting attitude is also, and for the same reason, characteristic; the person sits on one tuber ischii so as to relax the other side. Dr. Duffin, in an excellent summary of 26 collected cases,[1] draws particular attention to this lameness as a diagnostic sign, and points out its association with another tendency of these abscesses, namely, to implicate the pleura and lung. The mechanism of the lameness is explained by the pus following the track of the psoas;[2] and as the pus may follow this muscle downwards to the groin, so it may be guided by it beneath the ligamentum arcuatum to the pleural cavity. A case is recorded in which the pus took both directions; it ran along the psoas and between the pillars of the diaphragm, and also pointed in the groin.[3]

The local symptoms are a swelling or tumor in the region of the kidney, at first hard and resisting, and, if the parietes be thick and fat, indistinct and ill defined. It will best be detected by lifting, as it were, each flank in the fingers of one hand, and thus simultaneously comparing the resistance offered on the two sides. The affected side will often give the sense of increased resistance and weight, long before the abscess is large or prominent enough to give rise to any altered outline of the flank or abdomen. Deep-seated and often paroxysmal pain ushers in the disease; the pain may vanish for days or weeks, and then recur. A feeling of weight in the side is sometimes complained of by the patient, and I have seen œdema of the foot and ankle precede for many weeks the slightest sign of prominence in the loin. An inability to extend the thigh of the affected side has also in my experience occasionally been an early sign. The skin in the loin is often waxen and œdematous, unless the matter makes its way to the surface, and then it becomes congested. After a time, deep-seated fluctuation may be detected in place of the hard resistance previously felt; but this will depend much upon the thickness of the superjacent parietes. I have known as many as six pints of pus pent up, presumably for several weeks, in a perinephric abscess, and yet no fluctuation could be made out, owing to the enormous layer of subcutaneous fat. In this case an abscess in the testis of the same side for weeks preceded, and healed before the detection of, the perinephric abscess. The urine affords but a very imperfect guide, because, in the first place, it may have been long changed by antecedent vesical or renal disease, and because, in the second place, if the cause of the perinephric inflammation does not reside in the urinary organs, the urine itself may be quite normal; or at most there may be but a diminution in the quantity excreted, or it may contain some albumen as a result of pressure on the renal vein. When abscess follows injury to the kidney, the urine, which at first may have been blood-stained, may contain pus after suppuration has become established. The frequency of urinary complications, as seen from Dr. Duffin's list of 26 cases, was as follows: 2 patients had bloody urine; 6 had free pus in the urine; 2 had vesical irritation; 5 had renal disease without bladder signs; 12 were without urinary trouble of any sort. In the 2 cases in which blood was voided with the urine, the abscess was excited by severe injury to the loin.

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[1] Med. Times and Gazette, September 24, 1870, and November 16, 1872.

[2] See Dr. Dickinson's Case: Trans. Path. Soc. Lond., vol. xvi. p. 175.

[3] Lancet, July 4, 1863.

The pus contained in these abscesses is sometimes odorless, in others fetid; and owing to the close proximity of the colon even a fecal odor may be present without a fistulous communication with the bowel existing. Sometimes lung symptoms on the affected side mask all others, and the case appears at first sight to be one of pneumonia.

Terminations.—The prognosis is always grave. The duration of the disease varies from two or three weeks to many months. If the abscess be opened, or burst externally, or in a favorable direction internally, recovery may ensue, unless the cause of the abscess be incurable. When scrofulous disease of the kidney, or complete disorganization from impacted calculi, is the exciting cause, recovery may follow nephrectomy. If the abscess bursts into the lung, colon, or ureter, immediate relief from the general and local symptoms is experienced; and recovery may follow the discharge of pus in coughing, or by the bowel, or with the urine. On the other hand, it is possible, though fortunately not common, that fresh suppuration may be lighted up by extravasation of feces[1] or urine into the abscess, and a fatal termination arise from pyæmia, septicæmia, or gangrene of the lung.

If the abscess burst into the peritoneum, fatal peritonitis is the result; if into the pleural cavity, empyema will kill the patient. Death sometimes occurs from blood-poisoning, or from exhaustion; or it may be caused by the effects of pressure before the abscess has been opened, or has ruptured in any direction. Chest-complications are very common in these, as in sub-diaphragmatic peritoneal abscesses.

Compared with the frequency with which perinephric abscesses perforate the pleura, the other forms of spontaneous opening are rare. Probably in 5 out of every 12 cases which pursue their own course, the abscess opens into the pleural sac or lung. Quain and Dickinson[1] each record a case in which it opened into the groin. Duffin gives 6 cases (out of 26) in which the abscess opened into the colon, 1 in which it opened into the peritoneum, and 1 in which it opened externally at the loin.

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[1] See a typical case of this sort in the appendix to Dr. Bowditch's article on perinephritic abscess, in the First Med. and Surg. Report of the Boston City Hospital.

Diagnosis.—The history of the case, inquiry as to the probable or possible cause of the symptoms, the existence of some or all of the constitutional signs of suppuration, the lameness and position of the lower limb, the situation of the tumor, and the result of aspiration or of an exploratory incision in the loin, will serve to indicate the nature of the disease. Hydro-nephrosis and pyo-nephrosis, new growths of the kidney, spleen, or liver, enlargement of the mesenteric glands, and cancerous thickening of the ascending or descending colon, will in this way in all probability be excluded. The fever, the one-sidedness of the pain, and the attitude in standing or sitting, exclude lumbago. The absence of spinal deformity, and of other usual spinal symptoms exclude caries of the vertebræ. But the diagnosis is sometimes by no means simple.

Treatment.—In perinephritis, dry or wet cupping, early blistering, or the application of some other form of counter-irritation, may prevent suppuration. As soon as the presence of pus is suspected, it should be searched for with the aspirator, or by an exploratory incision in the loin. When matter is detected, it should be discharged through a free opening made like the incision in colotomy; the abscess-cavity should be washed out with a solution of iodine or carbolic solution, and a drainage-tube should be inserted. The loin should then be enveloped in a large hot fomentation of equal parts of water and carbolic-acid solution (1 in 40) applied on cotton-wool; or the carbolized gauze dressing may be applied. It is well to introduce the finger immediately after evacuating the abscess, so as to examine the condition of the kidney, and to detach any loose sloughs or remove any calculi which may be detected either within or outside the renal capsule. Absolute rest in bed should be enforced throughout. In 20 of the cases collected by Dr. Duffin[2] early puncture had been made—in 12 of these with complete success, and in 6 others "with a fair modicum of success."

The patient's strength is to be maintained by nutritious food and tonics; and stimulants should be administered at such times and in such quantities as the case requires.

Even when no pus exists, if the signs of acute or subacute perinephritis are followed by pain, tenderness, and swelling in the loin, much benefit will accrue from the relief of tension by the nephrotomy incision; and the wound should be prevented from healing by the introduction of a drainage-tube. In one case which has come to my knowledge, pus followed after a while the healing of the incision, though none escaped at the time of the operation. All pain, however, ceased at once, and the wound quickly healed; but shortly afterwards the cicatrix opened up, and pus escaped from the deep parts of the incision-track. The patient is now quite well, and able to get about.

While writing these pages my attention has happily been directed to an able article, with a series of 10 cases, by Dr. H. I. Bowditch.[3] In two of these cases early operations were performed, but no pus was observed at the time, and the operators considered that their operations had been in vain; but in both instances suppuration followed, and the tumors in the loin melted away.

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[1] Trans. Path. Soc. Lond., vols. v. and xvi.

[2] Med. Times and Gaz., Nov. 16, 1872, p. 556.

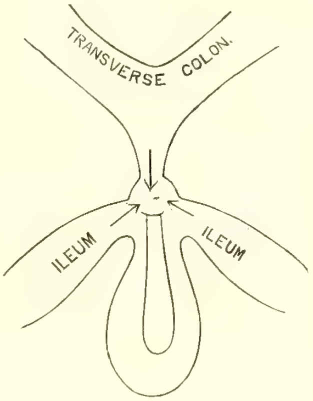
[3] Perinephritic Abscess, its Complications and its Treatment. First Medical and Surgical Report of the Boston City Hospital. 1870.

With Dr. Bowditch's conclusion as to early operation in these, and indeed in all abscesses about the peritoneal organs, I cordially agree, and I would strongly recommend the perusal of his article to all surgeons interested in the surgery of the abdomen. As he very rightly remarks: "If ever there be occasions for a *cautious boldness* on the part of the surgeon, these abscesses present them."[1]

VII. Fecal Abscess.—Fecal abscesses are of two kinds, namely, (1) those which are caused by the extravasation of fecal matter, and which, therefore, are fecal from their origin, and (2) those which arise from causes quite unconnected with the bowel, but which at length ulcerate into it and become fecal by the destruction which they have themselves wrought upon the walls of the intestine.

It must be noticed, however, that an abscess, originally fecal, may communicate again with the bowel by opening into it from without, and after exciting ulceration or sloughing of the intestinal walls. These secondary openings are often at a part of the bowel a long way from the original disease. Again, on the other hand, a simple abscess or cyst may be converted into a fecal abscess, not by the extension or pressure of the original abscess or cyst, but by the destructive progress of some independent, but coexisting disease. A case in point has been recorded by Dr. Bristowe:[2] an ovarian cyst, the size of a walnut, was converted into a fecal abscess with thin, offensive, feculent contents, by the bursting into it of a fecal abscess in the cellular tissue about the rectum, which in its turn had been caused by the perforation of the rectum by ulceration commencing in its mucous membrane. Another fecal cavity, circumscribed by adhesions, had been formed in the same case and by the same process of ulceration in the colon; and this cavity had effected two secondary communications with two coils of the upper part of the ileum. (Fig. 1125.) These orifices, though close together, were, when measured along the course of the ileum, about a foot apart. This single case illustrates the two complications of fecal abscess just referred to.

Fig. 1125.



Fecal abscess originating in disease of the colon, and communicating secondarily with the ileum at two places. (Bristowe.)

Situations of Fecal Abscesses.—Fecal abscesses might be classified also according to their situation, into two sets, namely, the intra-peritoneal and the extra-peritoneal. Intra-peritoneal abscesses may be situated in any part of the abdominal or pelvic cavities: between the diaphragm and stomach, or colon; amongst the coils of small intestine; in the neighborhood of the cæcum or sigmoid flexure, in the right or left iliac fossa, or in the pelvis; and between the rectum and uterus, rectum and bladder, or uterus and bladder; they occur also in the hypogastric region between the pelvic organs below and the coils of intestine matted together and adherent to the parts around, above; and lastly, they are formed between the parietal peritoneum on the one side, and adherent omentum, small or large intestine, or stomach, on the other. In fact, there is no end to the variety in the mode of formation of these circumscribed, fecal, peritoneal abscesses.

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[1] Trousseau's Clinical Medicine (Sydenham Society's Translation), vol. v. pp. 333-365, should be consulted. An essay by Krætschmar, (Des Abcés Perinéphriques. Paris, 1872) may also be consulted. Dr. J. B. Roberts, of Philadelphia, has recently published a very valuable paper in the Am. Journal of the Med. Sciences, April, 1883, entitled "The Clinical History and Exact Localization of Perinephric Abscesses," which, besides its own intrinsic merit, is valuable on account of the references it gives to the works of others. So, for this reason also, is Dr. Duffin's article, of which I have made free use.

[2] Trans. Path. Soc. Lond., vol. xiv. p. 203.

Extra-peritoneal abscesses may be situated in the abdominal parietes on the front or sides of the abdomen, and may begin between or beneath the muscular strata of the abdomen; or they may be retro-peritoneal in position, as many of those are which arise from ulceration or sloughing of the vermiform appendix, as well as those which begin in simple suppuration of the retro-peritoneal cellular tissue about the kidney and elsewhere; in other cases they commence beneath the pelvic fascia in pelvic cellulitis, disease of the pelvic bones, or as the result of sloughing of the bowel in cases of reduction *en masse* of a femoral hernia: in other cases, again, they open at the scrotum or on the inner side of the thigh, on the buttocks, in the perineum, or at the back of the trunk. Psoas, iliac, and ilio-pelvic abscesses occasionally become fecal. Both intra-peritoneal and extra-peritoneal fecal abscesses may either be fecal in their origin or become fecal in their progress. Probably the extra-peritoneal are the commonest, both in the primary and secondary forms.

Causes.—The primary abscesses most frequently result from some obstruction in the bowels, giving rise to perforation by ulceration of the intestinal walls, above the seat of obstruction. Cancer of the stomach, small intestines, cæcum, colon, sigmoid flexure, and rectum; the pressure of some tumor outside the bowel, or of a foreign body within it; the ulceration caused by gall-stones; the various diseased states of the appendix cæci; and tubercular and simple ulcers of the bowel; and, lastly, injuries to the abdomen, are all known causes of primary fecal abscess, both within and without the peritoneal cavity. Cancer is probably the commonest of all causes, and the morbid product sometimes infiltrates the whole of the walls of the abscess.

A case was in the Middlesex Hospital, in 1881, under the care of Dr. Cayley, in which epitheliomatous ulceration of the sigmoid flexure had led to a fecal abscess, which contained about four ounces of black, fetid, feculent fluid. The tissues around the abscess were infiltrated with cancer, and the edges of the ulcer in the bowel were hard with cancerous deposit.

After cancer, disease of the appendix cæci is the next most common cause; and cases are very frequently met with in which, ulcerated, perforated, or sloughing, this appendage of the cæcum is found adherent to the back of the cæcum, and in connection with a fecal abscess in the right iliac fossa. In other cases the cæcal appendix, having descended along the inguinal canal in a hernial sac, to which it has become adherent, has given rise to one or more fecal abscesses in the scrotum.

Mr. Shaw, my much respected colleague at the Middlesex Hospital, has recorded[1] a very interesting and instructive case, in which a succession of abscesses resulting in fistulæ formed in a scrotal tumor of very obscure nature. The matter discharged at first was healthy pus, but soon it became sanious, very offensive, and afterwards was of a pale orange color, but never distinctly feculent. The quantity discharged was always profuse, but sometimes increased greatly without any corresponding change in the condition of the tumor. There was no pus in the stools, and no interference whatever with the action of the bowels. The patient died at the end of a year, exhausted, and then the case was found to be one of omental hernia; the omentum adherent to the sac enveloped the vermiform appendix, which was healthy all the way down to within half an inch of its blind extremity, where it was in great part destroyed by ulceration, and communicated with the sinuses in the scrotum. The patient was an old man who was supposed to be suffering from disease of the right testicle, and when admitted under Mr. Shaw's care, in July, 1845, there was an irregular swelling of the scrotum with enlargement of the cord, but owing to the thickened condition of the skin and cellular tissue, the testis could not be felt. In a short time phlegmonous inflammation took place in different parts of the swelling, and the abscesses followed.

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[1] Trans. Path. Soc. Lond., vol i. p. 278.

Another case, recorded in the same volume of the Pathological Transactions by Dr. Thurnam,[1] was that of a gentleman who had long worn a truss for "an incipient right inguinal hernia." Suddenly the swelling increased, and became very tender and painful, and an abscess formed in the upper part of the scrotum, which was opened, giving exit to a little olive-colored, very fetid purulent matter, and gas. A second abscess formed below the first, and was opened five weeks subsequently. At the end of two months, the sinus left from the last abscess was laid open, and a triangular piece of hard bone, with sharp angles, was discharged the same day. From this time the sinuses closed. Death occurred from other causes some time afterwards, and it was then found that the hernia consisted of an enlarged and thickened appendix cæci, the apex of which was opaque and contracted, and adherent to the hernial sac by a firm band of adventitious tissue.

A case of fecal abscess from the ulceration of a diverticulum of the ileum, which had become invaginated in the sac of a right inguinal hernia, in an old woman aged seventy-seven, is recorded by Dr. Dowse.[2] This specimen, which I had the opportunity of examining, was a diverticulum from the lower part of the ileum, and was adherent along its upper and forepart to the sac of a direct inguinal hernia. There was no evidence of its ever having been strangulated or constricted, and the perforation had no doubt arisen by ulceration, beginning on the mucous surface. The patient recovered from the abscess with a fistulous opening, but died three months afterwards from a severe attack of diarrhœa.

Herniæ of the vermiform appendix are, perhaps, less rare than is commonly supposed, and such cases as the above should make the surgeon be at once on the alert in doubtful or obscure inflammatory swellings of the scrotum or groin.

I have on three occasions seen the cæcal appendix, either alone or with omentum, or the cæcum, in a hernial sac; and in one case—that of a woman, aged sixty-seven—it was so changed in appearance that it was mistaken for a band of adhesion, and cut through with the omental sac which surrounded it. The proximal end of the appendix cæci, with the stump of the omentum to which it was attached, was tied with catgut ligature and left outside the ring; and it was only after the operation and on microscopical examination, that the real nature of the structure was made out. Strangulation had existed for five days before the operation, and the knuckle of bowel, the size of a small apple, which was contained within the omental sac, was everywhere quite black, and in two places quite sphacelated. The patient died within forty-eight hours of peritonitis, which had become general before the operation.

In cases of perforating ulceration on the front or side of the cæcum, a circumscribed, intra-peritoneal abscess will form, provided that adhesions exist before the perforation occurs; otherwise death from fecal effusion into the general peritoneal cavity will result. Such an abscess will, however, in all probability soon open upon the abdominal wall, in the iliac region; unless, as sometimes happens, it has a downward direction towards the pelvis.

Allied somewhat to the cases of fecal abscess resulting from sloughing or ulceration of an unreduced hernia, are the intra-peritoneal abscesses which follow complete reduction, and the extra-peritoneal abscesses which result from reduction *en masse*. If complete reduction has been effected, and adhesions have had time to form prior to the giving way of the coats of the bowel, an abscess, circumscribed within the peritoneum, will form; but in a short time, most likely, it will open externally through the operation wound, or in the neighborhood of Poupart's ligament, and a fecal fistula, leading out of the abscess-cavity, will result. When a hernia has been reduced *en masse*, extravasation will sooner or later (if the patient does not die of strangulation beforehand) take place into the areolar tissue outside the parietal or pelvic peritoneum, or between the pubis and pelvic fascia.

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[1] Ibid., vol. i. p. 269.

[2] Ibid., vol. xxvi. p. 109.

I have seen two such cases, though not in my own practice, In one, a woman aged forty had been operated upon for strangulated femoral hernia ; a small bundle of bowel had completely sloughed away. Within a large fecal abscess-pouch, between the pubis and bladder, and beneath the pelvic fascia, there were two intestinal orifices, one leading into the portion of the bowel which entered, and the other into that which left the abscess-cavity ; all communication with the peritoneal cavity was completely shut off by firm adhesions between the parietal peritoneum and the bowel, and there was no general peritonitis ; the patient died of collapse. In the other case, a fecal abscess followed sloughing of a strangulated hernia in a pregnant woman. There was a large fecal abscess behind the pubis extending down to the neck of the bladder, and separating this viscus from the pubic symphysis. There was a sloughy opening into the ileum fifteen inches above the ileo-cæcal valve, large enough to admit a finger ; and an opening on the surface a little above and to the left of the pubis, from which sinuses burrowed in the parietes, both outwards towards the iliac crest, and forwards and downwards behind the pubis, just above which there was also a second opening. There was no evidence of past or recent general peritonitis. I have seen a third case of, as I believe, exactly the same kind as the first of the above, but the condition was not verified by a post-mortem examination.

Cancer of the uterus, bladder, vagina, or rectum is a frequent cause of both intra-peritoneal and extra-peritoneal fecal abscess; these are generally discovered on the post-mortem table, but they sometimes present themselves as circumscribed swellings, roofed in by coils of small intestine matted together, and adherent to the parietes in the hypogastric region.

The pressure of a pelvic tumor, by causing obstruction in the bowels, may lead to a large fecal abscess in the pelvic cellular tissue, which may open upon the buttocks in more places than one. I had such a case for a long time under my care in the Middlesex Hospital. By degrees the rectum had become completely flattened by the pressure of multiple uterine fibroids, and when the patient came under my notice there was great abdominal distension, and nearly all the fecal matter which escaped passed through fistulous openings in the buttocks, which burrowed out at both great sciatic foramina. Colotomy was performed ; the large abscess almost completely dried up ; and the patient lived for two years after the operation in comparative comfort. Dr. Wilks has put on record a case of multilocular cyst of the left ovary the size of a new-born child's head, on the right side of which was a fecal abscess communicating with the cæcum ; as no disease existed elsewhere, it is presumable that the abscess was caused by the irritation and inflammation set up by the tumor, but it is not actually said that such was the fact. The case is reported on account of the intra-cystic growths being covered by ciliated epithelium.[1]

Gall-stones may lead to intra-peritoneal abscesses which may be fecal at their origin, or may become so. The following is a good example of an extra-peritoneal fecal abscess from gall-stone ; as the patient recovered, it is impossible to say with what part of the bowel the fecal abscess communicated.

A healthy girl, aged ten, who had never ailed beyond occasional attacks of indigestion and bilious vomiting, suffered after one of these attacks pain extending from the right groin to the right back ; there was much tenderness over the cæcum, and the belly was tympanitic ; within a fortnight an abscess had formed in the back, and was opened ; it discharged at the time fetid, thin, brown pus, and gas ; and four days afterward a hard round substance the size of a nutmeg escaped from the wound. The child made a quick recovery. The concretion consisted of a nucleus composed almost entirely of cholesterine surrounded with feces. The biliary origin of the nucleus was beyond doubt.[1]

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[1] Ibid., vol. vii. p. 281.

Occasionally a fecal abscess may be avoided, although the bowel is entirely perforated by the adhesion of some neighboring organ to the edges of the ulcer. A case of syphilitic stricture of the rectum was under the care of my colleague Mr. Lawson, in 1881. There was a great deal of ulceration above the stricture, and at one spot, six inches from the anus, a perforation the size of a sixpence existed ; but no extravasation had occurred, as the left ovary formed the floor of the ulcer, though not absolutely adherent to its margin at all points.

The secondary fecal abscesses, those namely in which fecal extravasation takes place into an abscess already existing, may like the primary cases arise from many causes. These have been enumerated under the sections "Abscess of the Parietes" and "Circumscribed Peritoneal Abscess," "Retro-peritoneal Abscess," and "Ilio-pelvic Abscess." Did space permit, I might relate cases of each of these varieties of abscess which have at a later stage become fecal. I may however refer to the first case of fecal abscess ever recorded in the London Pathological Society's Transactions. It was published by Mr. Cæsar Hawkins.[2]

The case occurred in the person of a man, aged twenty-four, who fell from a height of twenty feet and ruptured his diaphragm. On the following day he complained of a fixed, defined pain on the left side, a little below the hypochondrium ; this was accompanied by slight hæmatemesis and inability to take food. Till the ninth day he progressed favorably, but then he was seized with collapse, attacks of which occurred subsequently at intervals till about the tenth week, when he was seized with pain in the abdomen accompanied by constipation, and followed by diarrhœa, and by the passage of blood by stool. An acute attack of pleurisy set in, of which he died in the thirteenth week after admission. He was kept alive by enemata the whole of the time, as the inability to take food by the mouth continued throughout. At the post-mortem examination, a large cyst was found in the lower part of the abdomen among the convolutions of the intestines, containing pus and fecal matter, and communicating with the lower part of the colon. In the left pleural cavity were two distinct, circumscribed effusions, the one at the upper and the other at the lower part of the cavity, between the lung and the diaphragm. There was a laceration an inch across in the diaphragm, and through this the lower pleural abscess communicated with another in the abdomen, behind the stomach, and bounded likewise by the spleen and kidney ; it contained about a half pint of pus. There was a further partial laceration of about six inches in length, in the part of the diaphragm forming the wall of this abscess.

In this case the seizure of abdominal pain, followed by diarrhœa and the passage of blood by stool, marks the time at which one of the circumscribed peritoneal abscesses opened into the colon, and in turn became fecal by the escape into it of some of the contents of the large bowel.

Symptoms.—Fecal abscesses are too diverse in their origin and course to allow of any description of symptoms applicable to all. Many of them have nothing in common ; and this is what would be expected by those who bear in mind that the abscess itself, in primary cases, is but a complication of some pre-existing morbid condition ; and that in the secondary class the fecal element is but an accident in the course of an abscess from whatever cause arising, just as in other persons, or under other conditions, the opening of an abscess into an artery, vein, or joint, is an accidental complication. It is, therefore, manifestly as absurd to regard fecal abscesses as a form of disease *sui generis*, as it would be to classify the others as "arterial abscesses," "venous abscesses," "articular abscesses," etc.

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[1] Trans. Path. Soc. Lond., vol. xxviii. p. 130.

[2] Ibid., vol. i. p. 150.

As all fecal abscesses come under one or other denomination—intra-peritoneal or extra-peritoneal—I must refer the reader to the accounts which have been given of the symptoms of the several kinds of abdominal abscess.

Three features may be mentioned, however, as specially characteristic of fecal abscesses, and though they are not always present, they very generally appear at some stage in the course of the disease. (1) Where fecal fluids and solids can reach, fecal gases can go also, and hence, with fluctuation, a degree of resonance or of emphysematous crepitation should be looked for. The pressure of gas in these abscesses is often evinced by the escape of bubbles, of fetid odor, as soon as an opening is made. When the abscess is sufficiently near the surface to be percussed, or to form a prominence or tumor, it will be found dull as long as no air has entered it; but if it become fecal by forming a communication with the bowel, air will very probably enter it and take the place of some of the pus which escapes into the bowel. (2) When after the ordinary symptoms of any abdominal phlegmon, pus is found in the stools; or a quantity of liquid, or putty-like, semi-liquid stools of a light color come away—which the patient may describe, as one of mine did,[1] as "coming away all cold;" or if diarrhœa with blood in the stools sets in, or a number of coagula are passed with the feces; under any of these circumstances the diagnosis is conclusive of an abscess in connection with the bowel. If after, or at the same time that any of these changes are seen in the stools, a pre-existing swelling, which was before dull, becomes tympanitic, the conclusion that an abscess has become fecal, is almost certainly correct. (3) When a fecal abscess reaches the subcutaneous cellular tissue in its course outwards, there are marked signs of diffused cellulitis of a more phlegmonous character, wider extent, and accompanied with more severe constitutional disturbance and depression than is seen in ordinary or non-fecal abscesses. The brawny hardness of the tissues is associated with marked tenderness and great pain, and an angry or livid red discoloration of the skin. As the abscess reaches the surface, diffused crepitation may be detected, and a soft boggy feeling is conveyed to the finger. Sometimes a large bleb is formed on the surface, or distinct patches of skin become gangrenous, and slough away, leaving a fistulous opening which discharges pus and fecal matter.

The symptoms of a fecal abscess may be the first indication, instead of one of the later ones, of some fatal disease.

This fact is illustrated by a case recorded by Dr. Thurman,[2] of extensive medullary cancer of the transverse colon, the first sign of which was an illness beginning with pain, fulness, and tenderness, in the right side of the abdomen. This attack subsided in a fortnight, and was followed in three weeks more by a circumscribed tumor, the size of an orange, just below the umbilicus. The tumor increased rapidly in size, and at the end of a week fluctuated, the fluctuation being combined with emphysematous crepitation. The swelling was opened, and gas and fetid feculent matter escaped, pus and coagula being mixed with the feces. Afterwards the abscess-walls sloughed, but subsequently all healed and closed entirely, though the scar re-opened. The patient died some months afterwards with extensive fungating cancer of the colon, sprouting into and filling the lumen of the gut; through the cancerous tissue there was a fistulous communication with the abscess. The abscess-cavity had been formed by the omentum, cæcum, and transverse colon, firmly adherent to the abdominal parietes below the umbilicus, and to one another. A second communication between the bowel and the abscess had been formed at the cæcum.

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[1] Lancet, July 14, 1883, p. 53. Case of "Rupture of the Urinary Bladder."

[2] Trans. Path. Soc. Lond., vol. i. p. 265.

Prognosis.—In the first class, or primary abscesses, the prognosis will depend chiefly upon the cause of the abscess; in the second class, or secondary abscesses, it is rendered less favorable by the abscess becoming fecal. As an instance of how rapidly a secondary fecal abscess even of great size may heal, the following case, under the care of Sir William (then Mr.) Lawrence, may be quoted:—

A woman, aged 22, fifteen days after a rigor and pain in the iliac and hypogastric regions, had an abscess opened in the left loin, and 70 ounces of fetid pus escaped. Three days afterwards, the bowels having previously been confined, 80 ounces of feces with some purulent matter came away through the incision, on the patient being moved in bed. In a few days the abscess healed, and the woman was discharged quite well. The reporter remarks: "The above is the only instance we remember in which some days after the opening of an abscess in the loin, the whole contents of the intestine came away through the wound, and then the opening in the gut closed completely and permanently, and the patient recovered entirely in three weeks."[1]

When an abscess discharges into the stomach or bowel, the patient's recovery is often insured thereby; but if a mutual interchange of contents goes on, and fecal matter passes into the abscess, the gravity of the case is much increased, even though an external opening also exists. In either class of cases, there are the dangers (1) of blood-poisoning, (2) of exhaustion from prolonged and profuse discharges, and (3)—when the abscess results in an external fecal fistula, and the communication with the bowel is high up in the tube—of the emaciation and starvation which result from the escape of the intestinal contents. Another danger is lest the abscess burst into the general cavity of the peritoneum; or again, the pus may burrow, and in its course destroy, to a greater or less extent, such important organs as the pancreas, spleen, kidney, lung, etc. None of these dangers, however, except that of starvation due to the escape of intestinal contents, are peculiar to fecal abscesses.

Sometimes recovery takes place after the formation of long and sinuous tracks, and after the abscess has been opened in several places, or resulted in the partial destruction of some muscle, such as the psoas or iliacus. Sometimes death takes place very slowly, and long after the abscess has settled down into a mere fistulous opening; in other cases the resulting fistula closes and breaks again and again, or a fresh abscess is lighted up in its track. Sometimes a fecal abscess will attain a large size in an insidious and "silent" manner, and without warning suddenly burst into the peritoneum, and so quickly cause death. Mr. Pollock, in Holmes's System of Surgery (third edition), gives a good illustration of fecal abscess, connected with disease of the appendix cæci, taking this course; and did space permit, cases illustrating each of the above statements might be quoted, and some of those already given in the text might be referred to in corroboration of their truth.

Treatment.—The treatment of fecal abscesses in their early stages does not differ from that of other abscesses. As soon as there are signs of extravasation of fecal matter or suppuration, a free opening should be made. Disinfectants, irrigation, and constant change of dressings will be requisite; the bedding and the air of the room must be kept as fresh as possible; pain must be allayed by anodynes, and the strength maintained by tonics, good diet, and stimulants.

When the cause of the abscess, or of the resulting fistula, persists, it should be removed, if possible; when this cannot be done, operative measures may at least relieve the patient's suffering, prolong his life, or even close the abscess, as the case in which I performed colotomy illustrates. When the abscess is due to reduction *en masse*, the bowel should be freely exposed, the parts thoroughly cleansed and disinfected, and the ends of the bowel sewn together, after cutting away what remains of the gangrenous tissues. To attempt division of the stricture of the hernia under these circumstances, without uniting the ends of the sloughed bowel, would only be to invite a hasty death by opening up the general cavity of the peritoneum to the putrid contents of the fecal abscess. When the abscess has been caused by the cæcal appendix in a hernial sac, the treatment would be to remove the diseased portion of the appendix, and then to close by sutures the cut extremity, taking care to invaginate the walls so as not to bring two mucous surfaces into apposition by the stitches.

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[1] British Med. Journ., August 22, 1857, p. 709.

The abscesses situated in the iliac fossa, and arising from cæcal or pericæcal disease, or from disease about the sigmoid flexure, should be treated by an early external opening. It is too generally a question in these cases of giving the patient the chance of relief afforded by the operation, or of leaving him to die without one.[1]

VIII. Ilio-pelvic Abscess.—Ilio-pelvic abscess is to be distinguished from ilio-psoas abscess. The latter owes its origin generally to caries of the lumbar or lower dorsal vertebræ, but occasionally to disease of the sacro-iliac joint, to strain of the muscular fibres, or to burrowing of a perinephric abscess; the former has a variety of causes.

Ilio-pelvic abscesses are of two sorts, (1) the sub-peritoneal, and (2) the sub-aponeurotic. The *sub-peritoneal* are prone to spread widely in both an upward and a downward direction, reaching the kidney, or even burrowing behind the diaphragm, and running in the opposite direction amongst the pelvic organs. Such abscesses are rarely circumscribed, and if not opened by the surgeon, are prone to burst spontaneously at some point in the lower part of the belly, or even at the umbilicus. Cases of this character have been described and referred to in the section on Retro-peritoneal Suppuration (see page 950). Bérard gives a case in which the abscess, starting in the left iliac fossa, burrowed across the median line in the hypogastric region, and reached the right iliac fossa, ultimately discharging itself at the navel. The abscess followed labor; the patient died. An abscess reaching up to the left iliac fossa, and opening in the linea alba, may arise from a lithotomy incision:—I have known a case in which a sinus opened two inches above the symphysis pubis, and exuded a thick pus, from an abscess on the left side of the true pelvis. The sinus-track led downwards in the fascia transversalis, behind the rectus, as far as the left groin; here it descended vertically behind the longitudinal ramus of the pubis into a large abscess cavity; an off-shoot of the sinus, before dipping thus downwards, ran outwards for a short distance towards the anterior superior spine of the ilium, and there ended in a *cul-de-sac*. The lithotomy wound, which was very large and lined with phosphates, extended back to the level, and just to the left side, of the orifice of the ureter, but was shut off from the pelvic abscess referred to.

The *sub-aponeurotic* abscess forms between the fascia iliaca and the iliac muscle. For a time it is circumscribed, but if not evacuated, the pus burrows to the front of the thigh, which it reaches by passing beneath Poupart's ligament between the anterior superior spine of the ilium and the outer edge of the crural sheath. In some cases the hip-joint has been opened by the pus following the course of the ilio-psoas tendon and bursting through the thin part of the capsular ligament, at the spot where those muscles cross the articulation. I have amputated the limb at the hip-joint in a lad of seventeen, for necrosis of the acetabulum, which apparently had an iliac origin; suppuration within the pelvis had for a long time preceded hip-joint disease, and the abscess, after opening above Poupart's ligament, extended around the great sciatic notch to the back of the hip, and then into the hip-joint, which became completely disorganized. The case ended fatally, and the post-mortem examination disclosed extensive necrosis of the inner surface of the expanded wing of the ilium, and what remained of the iliacus muscle was quite black and softened. In other instances, the pus having burst through the iliac fascia, and extended below the brim of the true pelvis, has passed out through the great sacro-sciatic notch into the gluteal fossa, where it has burrowed beneath the gluteal muscles. I have opened such an abscess in more than one place in the buttock, as well as in the upper part of the thigh, pus being subsequently discharged into the bladder as well, and the flow being kept up in spite of free drainage. Suppuration may, I believe, extend from a diseased hip-joint by the same route into the pelvis, but it is then subperitoneal in character, not sub-aponeurotic. It is well known that hip-disease often extends through the floor of the acetabulum to the pelvis.

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[1] See an article by Dr. Willard Parker. Med. Record, March 1, 1867.

In 1881, a case was under the care of my colleague, Mr. Geo. Lawson, of sub-aponeurotic iliac abscess on both sides; it was not of vertebral or sacral origin, but the exact cause could not be made out at the autopsy. In this case of Mr. Lawson's, the abscess of one side did not communicate with that of the other. On the left side, the abscess had broken into the sheath of the psoas, and the pus had descended below Poupart's ligament; on the right side, the abscess had ulcerated through the sheath of the iliacus and opened above the crest of the ilium in two places—in the right groin, and over the right side of the middle sacral vertebra. The case shows that an iliac abscess may become an ilio-psoas abscess, and therefore that the latter may occur without any assignable cause such as caries of the vertebræ.

Ilio-pelvic abscesses have been known to evacuate themselves through the uterus and vagina, but much more frequently they are discharged through the rectum, sigmoid flexure, or bladder. Sometimes they have proved rapidly fatal by bursting into the general peritoneal cavity.

Occasionally the sub-aponeurotic abscesses result in the more or less complete destruction of the iliacus muscle and the periosteum of the iliac fossa, as in the case just referred to. The psoas and quadratus lumborum muscles sometimes share in the destruction. The iliac vessels and the anterior crural nerve, external cutaneous, obturator, and other branches of the lumbar plexus, as they pass across the pelvis are affected by contact with the pus, or suffer compression owing to the indurated and contracted condition of the inflamed tissues which surround them.

Causes.—Ilio-pelvic phlegmons are perhaps most commonly seen as sequelæ of labor, and it is supposed that they are most frequent among primiparæ. They occur, however, from several other causes, such as injury, periosteal and osteal inflammation, laceration of muscular fibre, and extravasation of blood. In one case, already referred to under the heading of Hepatic Abscess, suppuration was started in the pelvic cellular tissue by a lithotomy wound; the pus took the course of the spermatic cord, and burrowed along the inguinal canal to the scrotum, at the upper part of which it was evacuated through an incision. Velpeau saw such a phlegmon follow inflammation of the bursa beneath the ilio-psoas tendon on the brim of the pelvis; and in another instance a suppurating bubo excited abscess in the left iliac fossa by direct continuity of inflammatory action. Inflammation beginning in the pelvic cellular tissue is anatomically prone to spread to the iliac fossa.

Diagnosis.—The ilio-pelvic abscess has often been mistaken for pelvic peritonitis, and sometimes for ilio-psoas, or psoas abscess.

In iliac abscess, the constitutional disturbance is for a time often very slight; it is only after prolonged suffering or suppuration that the digestive organs fail, and that the patient emaciates or becomes hectic. In pelvic peritonitis, on the other hand, fever, vomiting, and hiccough, are early and severe symptoms; and whatever swelling is appreciable is in the vaginal *cul-de-sac*, not in the iliac fossa, and rarely in the hypogastrium, except in those cases already referred to in which circumscribed peritoneal abscess occurs from cancerous enlargement and ulceration of the uterus. The swelling, moreover, in pelvic peritonitis is doughy in character, not hard, resisting, or elastic. Pelvic peritonitis is always symptomatic, and is most frequently brought about by inflammation of the ovaries or Fallopian tubes; hence, in doubtful cases, the coexistence of some affection of these organs favors the diagnosis of peritonitis rather than that of ilio-pelvic abscess. The tumor which it forms is due to matting together, as a consequence of the inflammation, of the intra-pelvic viscera; and the purulent collections, when such occur in cases of pelvic peritonitis, are intra-peritoneal, not in the cellular tissue of the pelvis or iliac fossa. Jarjavay,[1] Lefort, and Goupil have demonstrated four layers of aponeurosis within the upper part of the broad ligaments, constituting a kind of fibrous frame of the upper border and determining its shape, and completely shutting off the organs contained within it—viz., the tubo-ovarian apparatus, the round ligament, and the utero-ovarian vessels—from the cellular tissue situated within the external or serous envelop of the ligament. Thus, as M. Bernutz[2] points out, abscesses developed in the cellular tissue of the broad ligament are below this aponeurotic sheath of the Fallopian tube and ovary, and the pus almost necessarily tends towards the abdominal walls, or else to the deep iliac fossa.

In acute cases of iliac and ilio-pelvic abscess, especially some of those which are caused by injury, the symptoms are, however, severe from the first, and do not subside until pus is evacuated either into the bowel, bladder, or vagina, or externally. Dr. Bowditch[3] has published a case which is illustrative of the truth of this statement, as well as instructive from the point of view of prognosis and diagnosis:—

A slater, aged twenty-five, was admitted into the Massachusetts General Hospital, having fallen a height of thirty feet, striking his face and hands. Intense pain in the lumbar and umbilical regions, with bloody urine, removed by the catheter, were the immediate symptoms. He continued to grow worse, the pain was violent, the abdomen was tympanitic and very tender, induration formed in the left lumbar and hypochondriac regions, and an inclination to point was evinced in the left inguinal region at the end of the fourth week from the injury. On introducing a tube into the rectum to relieve the flatulent distension of the bowels, a large quantity of pus and mucus, and a little feces came away. The swelling in the inguinal region and general tympanites nearly wholly disappeared thereupon; but pus continued to be discharged daily from the rectum, and the patient left, "much relieved," within two months from the accident. But he never recovered. Six months afterwards he was phthisical; in another month, he again had severe pain in the left groin, and in still another month, or thereabouts, "a tumor, tympanitic, disappearing on pressure, painful, and gurgling" was detected in the left groin, and diagnosed to be psoas abscess. The patient died within eleven months of the injury, and at the post-mortem examination there was found a large abscess in the left iliac fossa, opening into the bowel two feet from the anus; and from this abscess pus had burrowed down under Poupart's ligament into the thigh, five inches below the anterior superior spinous process.

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[1] Anatomie Chirurgicale, t. ii. p. 596.

[2] Bernutz and Goupil, Clinical Memoirs on the Diseases of Women, New Sydenham Society's Transl., vol. ii. p. 4.

[3] First Med. and Surg. Report of the Boston City Hospital, p. 64. 1870.

This case shows that, even though an abscess of this sort opens into the bowel, and free evacuation is followed by apparent convalescence, there may remain behind a residuum of disease, which may be easily aroused into further and fatal suppuration. Nor can one resist the conclusion drawn by Dr. Bowditch, that if an opening had been made at an early period, or even just before pointing and the fistulous opening into the intestine occurred, a fatal result might have been prevented, nay, even a perfect cure effected. Dr. Bowditch attributes the phthisis to the undermining of the health by the abscess and the prolonged discharge from it; but whether this was so or not, the impaired health from lung-affection found a focus for further mischief in the remains of the iliac abscess with its communication with the bowel; and one of the worst forms of abscess was soon induced, namely, a tympanitic, gurgling abscess, due to the ingress of fecal gas through the only existing aperture available for drainage.

In some cases the symptoms simulate rheumatic affection of the hip-joint. Dr. Louis Atlee, who has given a concise account of iliac abscess in the American Journal of the Medical Sciences, October, 1883, there records a case of abscess in the left iliac fossa, after labor of thirty-six hours' duration, in which for a month the illness was mistaken for rheumatic disease of the left hip-joint. The case is of further interest as showing the burrowing character of iliac abscess, and as a set-off against Dr. Bowditch's case; for in Dr. Atlee's case, recovery took place after a slow convalescence:—

A swelling appeared in the left iliac fossa eighteen days after the commencement of pain, and subsequently a left gluteal swelling was opened and a large quantity of pus escaped. At a later period, a swelling formed in the linea alba, midway between the umbilicus and pubis, and after bursting discharged a pint of pus. Rather more than three months after the commencement of the illness, a quantity of pus was discharged by the rectum, and from this time the patient slowly recovered.

Mr. Mitchell Henry has published[1] the case of a sailor, aged 20, who came into the Middlesex Hospital on December 19, 1849, complaining of pain in the loins and left hip-joint, and moving so like a person laboring under morbus coxarius as to lead to his being classed among the patients for admission into the surgical wards. Examination showing that there was no active disease of the hip-joint, he was sent into a medical ward, on the supposition that he might have disease of the kidney. It was found that he had been passing a large quantity of pus with his urine for three weeks; on December 22, he began to pass blood with his water, and the purulent deposit continued; on December 26, the blood had ceased, but the pus continued to pass; on January 3, he died in much agony, but conscious to the last. At the post-mortem examination, the abdominal cavity was found to be filled with pus from an abscess, and not the result of peritonitis. The peritoneum was in an early stage of general inflammation. The bladder contained pus, and was perforated just beneath the peritoneum by an ulcer as large as a sixpence; and it thereby communicated with a large abscess in the situation of the left vesicula seminalis, which was nearly destroyed by suppuration. There was no disease of any other structure or organ in the body. Mr. Henry remarks, that, though acute inflammation of the vesiculæ seminales is not likely to occur, chronic inflammatory processes are not infrequent, and may occasion abscesses, the exact diagnosis of which must be difficult. Such abscesses might be confounded with suppuration in the prostate gland, with disease of the hip-joint, with intra-pelvic abscess, and the like. He also describes a very similar case communicated to him by Mr. Cock, of Guy's Hospital, in which hip-joint disease had been thought to exist, but was decided by Mr. Cock not to be present; the abscess was detected and opened through the rectum, and the patient recovered.

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[1] Med.-Chir. Trans., vol. xxxiii. p. 306.

Symptoms.—The tumors to which ilio-pelvic abscesses give rise, are often appreciable to the eye and touch in the inguinal and hypogastric regions, and are scarcely within reach of the finger in the vagina. There is an absence, at any rate for some time, of the general symptoms of peritonitis; whereas in purulent or sero-adhesive pelvic peritonitis with swelling similar to that of ilio-pelvic abscess, the diagnosis will rest upon the existence of the general symptoms of peritonitis in the one case, as compared with those of inflammation of the cellular tissue on the other. (Bernutz.) Fatal acute peritonitis may, however, be excited by extension of inflammation from an iliac abscess, as the following case proves:—

Mary S—, aged 17, a domestic servant, unmarried, was admitted into the Middlesex Hospital, under Dr. Coupland's care, on December 4, 1882, complaining of a severe and constant cutting pain in the lower part of the belly; the pain was much aggravated by micturition. Three weeks before this date she had miscarried (about the third month of pregnancy), after lifting a heavy coal-scuttle. She did not feel very ill at the time, and, after lying down for a while, resumed her usual duties. At the end of a week she commenced to experience more abdominal pain, and took to her bed for a few days. Then feeling better she resumed her work, but the pain returned with increased severity, and she sought admission into the hospital. She was a fairly nourished, but anæmic blonde, and was evidently suffering extremely. The pulse was small and rapid (140); temperature 99.8° F. On examination the abdomen appeared much distended, and in the hypogastric region (where marks of recent leech-bites were seen) there was an area of resistance and tenderness, reaching from the pubes to midway between this point and the umbilicus, and extending laterally for two inches on each side of the median line. There was dulness on percussion over the central part of this area; but elsewhere the abdomen was tympanitic. There was also general tenderness, although this was not marked in the region indicated. Belladonna was prescribed, and hot fomentations were applied. An enema was administered, and this was followed by a copious evacuation. The patient's condition on the following day was not improved, and she vomited once in the evening. On Dec. 6, the temperature rose to 103.4°; the pain increased; the tongue was dry, and about 7 P. M. vomiting again set in, accompanied by collapse. Death occurred at 10 P. M. The post-mortem examination was made by Dr. Fowler. On incising the abdominal wall, the sac of an abscess was discovered just above the symphysis pubis; it was triangular in shape, the apex pointing upwards, and it was situated behind the tendons of the recti muscles. It measured about two and a half inches on each side. The peritoneum was everywhere intensely inflamed, covered with recent lymph, and injected; and on the right side of the pelvic brim there was a sac about the size of an orange, with thickened and pigmented walls, communicating by a pin-hole perforation with the above-mentioned abscess. This sac was formed in the sub-peritoneal tissue covering the psoas and illiacus muscles, and the peritonitis was apparently due to extension of inflammation, and not to rupture of the sac. The uterus was rather larger than usual, and contained some extravasated blood. The bladder, rectum, vagina, and ovaries were normal. The spleen was small, but normal; the liver pale and soft; the kidneys slightly congested; the heart natural; the lungs somewhat engorged.

In ilio-pelvic abscess retraction of the thigh may exist, as it does in ilio-psoas, and occasionally in perinephric abscess. Phlegmons of the iliac fossa, when they occur, as they most frequently do, in the puerperal state, begin with abdominal pain and febrile reaction about eighteen or twenty days after labor. The pain is not sharp, like that of pleurisy, but dull and throbbing, like that of boil or abscess elsewhere. "True phlegmons of the broad ligaments," says Bernutz,[1] "seem to be frequently a kind of early manifestation of puerperal fever itself—a sort of critical abscess; and like the phlegmons of the superficial iliac fossæ, they have many points both of resemblance and of difference with pelvi-peritonitis. The hypogastric swellings, characteristic of both affections, have these points in common; they are deep-seated, they push aside the intestine so as to fill the iliac fossa; and neither the one nor the other shows, at first, any very marked sign of phlegmon, which will appear subsequently in inflammation of the cellular tissue, but be absent altogether in cases of pelvi-peritonitis." Obstinate vomiting, colliquative diarrhœa, and pains in the legs, loins, and pelvis, sometimes precede or accompany the general symptoms of pelvic inflammation, and the lower limbs may become œdematous from plugging of the crural veins, as the following case of M. Brouardel, quoted by Bernutz, shows:—

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[1] Bernutz and Goupil, op. cit., vol. ii. p. 150.

L. M., aged 21, one week after labor experienced pains in the legs, loins, and pelvis. The pains were most acute in the left iliac fossa, and in the lower limbs, which became œdematous; she had obstinate vomiting and colliquative diarrhœa. An abscess subsequently formed in the iliac fossa, and made its way externally in the sacral region, where it discharged a good deal of pus. Hectic fever supervened, and she gradually sank, and died within five weeks. On post-mortem examination the peritoneum and abdominal organs were all found healthy; a fluctuating swelling existed in the left iliac fossa, due to pus which had burrowed in the iliac muscle; the broad ligaments, ovaries, and Fallopian tubes were healthy. The crural veins were obliterated by a clot, which had the appearance also of containing pus.

Though there is, as has already been stated, generally an absence of vaginal swelling, yet sometimes an induration, higher and less easily reached than in pelvic peritonitis, is felt in the later stages of these abscesses. Bernutz records a case in which there was a collection of pus between the two layers of the iliac mesocolon, resting above the broad ligament and readily discoverable by examination; it resulted from an extension of inflammation from an abscess which filled the iliac fossa, and occurred in a woman who died of erysipelas in the course of these puerperal phlegmons.

Treatment.—The treatment will be the same as for other forms of intra-pelvic or abdominal inflammation. Absolute rest, and the use of opium, hot fomentations, liquid nourishment, and gentle laxative medicine to prevent an accumulation within the bowels, are the measures indicated. As soon as fluctuation is detected, a puncture or an incision should evacuate the pus; but fluctuation should not be waited for, and if there is reasonable ground for suspecting pus, it should be searched for with a large grooved needle or fine trocar, and a free escape and drainage should be provided. Though recovery will often take place as soon as the pus has been discharged into the bowel, vagina, or possibly even the bladder, yet fatal consequences sometimes arise after and from this event, and, moreover, it can never be determined that this will be the course taken by the abscess, which may just as likely set up fatal peritonitis by extension of inflammation to, or by bursting through, the peritoneum. A good plan of applying continuous warmth to the abdomen is by means of Leiter's coil,[1] which I have used somewhat extensively and can strongly recommend.[2]

IX. OVARIAN ABSCESS.—Ovarian abscess is very rare, and its correct diagnosis during life is much rarer still. In fact, it is generally extremely difficult, and sometimes quite impossible, to diagnose it at all.

Causes.—Abscess of the ovary is said to occur most frequently in association with pelvic suppuration after labor.

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[1] A modification of Petitgand's mediate-irrigation coil. See Fig. 272, Vol. II., page 173, *supra*.

[2] See, in connection with the subject of ilio-pelvic abscess, Velpeau et Bérard, Manuel d'Anatomie Chirurgicale; Grisolle, Les tumeurs phlegmoneuses des fosses iliaques (Archives Générales de Méd., t. iv. 1839); Bernutz and Goupil, op. cit., vol. ii.

Sir James Simpson, Bernutz, Lawson Tait, and others have however recorded cases of abscess of the ovary resulting from acute ovaritis in childbed, due to septic causes, but quite distinct from general septic peritonitis in which the ovary has become involved secondarily to the peritoneum. Apart altogether from pregnancy and parturition, it may be excited by any chronic source of ovarian irritation, and may be preceded by many years of ovarian, uterine, or other pelvic trouble.

I have recorded a case[1] in which fatal peritonitis was excited by a small abscess in the left ovary of an unmarried woman, aged thirty-two, who for six months had been subject to attacks of retention of urine and other bladder troubles, due to the presence of a myoma of the uterus.

Mr. C. J. Cullingworth[2] has published a case of abscess in both ovaries. The woman, aged forty-five, had for several months been losing strength, and for six weeks had suffered from vomiting and pain in the abdomen. The right ovary ruptured, and its purulent contents escaped between the layers of the abdominal parietes, giving rise to such a degree of abdominal swelling as to lead to the supposition that the case was one of suppurating ovarian cyst. The patient died of peritonitis, and at the post-mortem examination the uterus was found thickened antero-posteriorly, "owing to the presence in its anterior wall of three small fibroids, the largest of which was equal in size to a pigeon's egg."

Mr. Lawson Tait records[3] the case of a woman aged thirty-eight upon whom he performed oöphorectomy, and in whose left ovary was an abscess containing about two drachms of pus, on the point of bursting into the peritoneal cavity. This patient had suffered for many years from great ovarian pains, and her catamenia occurred fortnightly, and, though scanty, were prolonged for a week or ten days. It is quite possible that in this case also some small uterine myoma may have been the cause of persistent ovarian irritation.

As abscess is an occasional termination of acute ovaritis, any of the causes which produce acute inflammation may lead to suppuration. These are violence, gonorrhœa, immoderate sexual intercourse, intra-uterine injections, the application of strong caustics to, and other operations upon, the uterus, the sudden suppression of the menses from cold, sudden shock, fatigue, etc. Andral mentions the case of a woman, aged thirty-six, who died from the effects of sudden menstrual suppression from cold; the left ovary was enlarged and contained pus. Wilks and Moxon "have met occasionally with pyæmic abscesses of the ovary, and an abscess in phthisis, but no tubercle." Tubercle is however another cause of ovarian abscess, and although tubercle of the ovary is usually, if not always, associated with tubercle of other organs, still this disease in the ovary may outstrip and overshadow that in any other of the affected parts, and through its secondary effects may cause death.

Mr. Cullingworth has published a second case[4] of abscess in both ovaries, in a young woman aged 26, of strumous history and chronic ill-health, whose catamenia had been absent for twenty-seven months. As in his first case, so in this, the abdomen was uniformly enlarged; but in this case the enlargement was owing (1) to the greatly increased size of the suppurating ovaries; (2) to the effusion into and general thickening of the peritoneum; and (3) to the matting together of the intestines by old adhesions. Death occurred from peritonitis, and at the post-mortem examination several little masses of cheesy material, rather smaller than a pea, were found in the lungs near their posterior borders, and similar cheesy nodules existed in the kidneys and spleen. The right ovary measured $4\frac{3}{4}$ by $3\frac{1}{4}$ inches, and the left $7\frac{1}{4}$ by 5 inches. Both were filled with offensive pus, were displaced towards one another, and were adherent together by a band of adhesion behind the uterus. The left ovary had been perceptible through the abdominal wall during life.

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[1] Brit. Med. Journal, May 21, 1881.

[2] Lancet, Nov. 3, 1877.

[3] Diseases of the Ovaries, 4th ed., p. 125.

[4] Lancet, Nov. 10, 1877.

Pathology.—Inflammation set up by puerperal causes, involves the entire ovary, though, perhaps, the stroma only is affected at first. When excited by causes other than puerperal, it is frequently limited to the follicles of the gland. There are thus three conditions in which abscess is seen: (1) In puerperal cases, suppuration being set up equally throughout, the ovary is quickly converted into a pus-cyst. Of the other two conditions, the one is in most cases possibly but the earlier stage of the other. (2) Sometimes, as in the case referred to above,[1] the ovary suppurates at various points, several small collections of pus being seen on section. If one of these, not larger, it may be, than the rest, is near the surface of the ovary, periovaritis may be excited, purulent lymph may be deposited upon the organ, and ulceration or sloughing at some minute point may cause an explosion of fatal peritonitis. Here the suppuration has begun in the separate follicles of the ovary, and death has ensued before the several purulent depots have coalesced so as to form one considerable abscess. (3) In other cases, the fatal result does not take place until the various suppurating foci have united into a single abscess, and a large part of the organ has become a mere shell or cyst, filled with offensive pus. Either of the two latter conditions may be met with, whether the abscess has a tuberculous or a simple inflammatory origin. Sometimes the fatal termination is delayed until the abscess has expanded to such considerable dimensions as to be detected, on palpation during life, through the abdominal walls. Sometimes the inflammation in the ovary leads to occlusion and dilatation of the Fallopian tube of the same side; and the two together give rise to a swelling still more marked on vaginal or rectal examination, if not through the parietes of the abdomen. It is a common thing for the affected ovary to become agglutinated to one or several of the pelvic organs, or to the small intestines, appendix cæci, sigmoid flexure, or pelvic parietes. The adhesions thus formed often give rise to circumscribed spaces within the peritoneal cavity, and these, by recurring inflammatory attacks, become abscess-cavities, into one of which the abscess may burst. In other cases the ovarian abscess bursts into one of the adherent viscera, and thus may discharge itself externally through the vagina, rectum, or bladder. In other cases, again, it bursts into the general peritoneal cavity, but the inflammatory thickening of the peritoneal coat of the ovary often prevents this happening for a long time, if not altogether. The abscess may burrow beneath adhesions within the peritoneum, in addition to bursting through a pelvic viscus; and by the agglutination of the structures in the pelvis the ureter may be so compressed, inflamed, and thickened, as to lead to the same consequences to the kidney as are so often caused by stricture of the urethra, cancer of the uterus, etc. The following case is in point:—

A married woman, aged 33, was admitted into the Middlesex Hospital, under the care of Dr. Powell, on November 3, 1882, for what was supposed to be strumous pyelitis. After two months of extreme illness she died; and at the post-mortem examination the left ovary was found adherent to the rectum and tissues around. It contained a dark, blackish tract of inflammation, and was in communication with the rectum by a small sinus which opened into an abscess within the gland. This abscess was also in communication with a sinus which passed above the bladder, beneath some coils of intestine which were closely adherent to that viscus, and on separating which the sinus was exposed. This sinus ended in a *cul-de-sac*, formed by the right ovary and some adhesions around it, and contained pus. The great omentum was adherent to the peritoneum of the pelvis. Besides the communication between the ovarian abscess and the rectum, there were two other communications with the rectum, close to the first, but leading into an abscess-cavity by the side of the ovary. The left ureter was much thickened and inflamed; the greater portion of the secreting structure of the left kidney was destroyed; four ounces of creamy pus were contained within it, and the organ was somewhat similar to a sacculated kidney. The bladder was full of pus, but there was no cystitis.

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[1] Brit. Med. Journal, May 21, 1881, p. 793.

Tubercular ovaritis is very analogous to tubercular orchitis: there is in each organ an admixture of pus and softened tubercle; and, as in the case of the tuberculous testis the epididymis and vas deferens become the deposit of tuberculous material, which infiltrates their lining membrane and often breaks down into pus, so in the case of the ovary, the Fallopian tube suffers in the same way. Further, the serous and purulent effusions and the tubercular inflammation of the tunica vaginalis testis, find their equivalent in the pelvic peritonitis of the female. Tubercular disease of the mesenteric glands and miliary infiltration of the lungs are found associated with tubercular ovaritis as well as with tubercular orchitis. Bernutz points out a further analogy still, for he says:—

> After puncture, pus, and with it, as we have found, part of the ovary, escapes, *per rectum*. This evacuation is followed by a temporary improvement, similar to that which follows in tubercular orchitis, when a puncture or incision of the distended tunica vaginalis allows the escape of pus and testicular *débris*. Then follow alternations of improvement and exacerbation, during which the constitution becomes seriously altered, and signs of pulmonary tubercularization appear, just as obtains in tubercular orchitis.[1]

Symptoms and Diagnosis.—Ovarian abscess may be preceded by the symptoms of acute ovaritis, or it may occur so insidiously as to excite no symptoms until the pelvic peritoneum is inflamed. In the first case, pain will be complained of in the lower part of the abdomen, groin, and inner side of the thigh, and this will be accompanied with considerable febrile disturbance, restlessness, and nausea. The pain varies, being sometimes very intense, but more frequently only a continuous, dull aching, with recurring, severe exacerbations. If the pelvic peritoneum be involved in the inflammation, other symptoms will be added according to the precise part of the serous membrane which is inflamed; thus, if it be the peritoneal covering of the bladder, micturition will be frequent and painful; if that of the colon, sigmoid flexure, and rectum, tenesmus, with the accumulation of scybala, may result.

Vaginal examination shows the uterus to be unaffected, but on pressing the finger against the top of the vagina, on the affected side, extreme tenderness will be detected. Probably the inflamed ovary will be felt to be enlarged and lower in position than the sound one; with the finger in either rectum or vagina it will seem to be about the size of a walnut, movable, and exquisitely sensitive. The formation of pus may be indicated by rigors; elevation of temperature, and increased frequency and feebleness of the pulse, with a red and glazed tongue, are pretty sure to occur. Sickness will be troublesome, and a sense of weight and throbbing pain will be experienced over the greater part of the lower half of the abdomen. Pus may however form without giving any indication of its existence, as in a case recorded in the Lancet for 1852.[2]

If the abscess is not preceded by the symptoms of ovaritis, there will be nothing to suggest its onset, and its course is pursued unnoticed until symptoms due to secondary pelvic peritonitis and adhesions occur. Indeed, in the majority of instances the diagnosis of ovarian abscess is never made, and the abscess is discovered only on the post-mortem table; whilst during life the symptoms are attributed to pelvic peritonitis, pelvic cellulitis, or "inflammation of the bowels." Yet a vaginal or rectal examination would clear the way to a right diagnosis by disclosing an enlarged, elastic, and tender swelling, of the size and in the situation of the ovary.

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[1] Bernutz and Goupil, op. cit., vol. ii. p. 23.

[2] Lancet, July 24, 1852, p. 75.

Prognosis.—The abscess may remain a long while without rupturing. Occasionally there are observed in the post-mortem room such changes in the pelvic peritoneum and cellular tissue, and in the ovary, as to lead to the impression that the ovary has at some former time been the seat of suppuration, and that recovery has followed the rupture of the abscess. It must, however, be admitted that other lesions may produce the same appearances, and further, that the more probable effect of the bursting of an ovarian abscess inwardly is death, either from shock or acute peritonitis, or from the burrowing or extension of a pelvic abscess which has been circumscribed for a while by inflammatory adhesions formed before the rupture has occurred.

Should the abscess burst into the bowel, vagina, or bladder, temporary relief or permanent cure may result, but not unfrequently the opening closes and the abscess cavity refills again and again, until the patient is worn out by suppuration or killed by blood-poisoning. The extent to which suppuration within and behind the pelvic peritoneum may occur, and the multiple fistulous communications which may be formed with the intestines, bladder, and external surface, as the result of ovarian suppuration, have already been alluded to in previous sections of this article. It is sufficient to say here that general peritonitis, pelvic peritonitis, pyelo-nephritis and renal abscess, cellulitis, iliac abscess, and diffused abscess in the abdominal parietes (see one of Mr. Cullingworth's cases especially), are some of the various complications to which abscess of the ovary may give rise, and that either of them may have a rapidly fatal result.

Treatment.—Prior to suppuration, treatment should be directed to overcome the ovaritis, or, when possible, to remove the cause which has set up the ovarian irritation. When suppuration has occurred, the question of relief by operation must be considered. If the abscess is pointing towards the vagina or rectum, it should be opened with a trocar or bistoury, and when possible drained. If it does not point in any accessible direction, abdominal section followed by the removal of the diseased ovary ought to be performed. I should not hesitate in future in following the teaching of Mr. Lawson Tait, in this class of cases, namely that, when the health is destroyed or life threatened, and when the condition is not evidently due to malignant disease, an exploratory operation should be performed, and the diseased uterine appendage removed. If the cause of the ovarian disease were a uterine myoma, such an operation, besides removing the diseased ovary, would also have a beneficial effect upon the uterine growth, and there would therefore be a double reason for performing it, unless, as in my case above referred to,[1] the tumor by its pressure had already completely disorganized the kidneys and ureters. Mr. Tait records, in the last edition of his work on Diseases of the Ovaries,[2] two successful cases in which this operation was performed.

XI. HÆMATO-SALPINX, HYDRO-SALPINX, AND PYO-SALPINX: ABSCESS OF FALLOPIAN TUBE.—*Hæmato-salpinx*, or distension of the closed Fallopian tube with blood; *Hydro-salpinx*, or dropsy of the Fallopian tube; and *Pyo-salpinx*, or distension of the closed Fallopian tube with pus, are conditions of great clinical importance, and likely to become still more so now that it is clearly proved that they can be very successfully remedied by surgical operation. Further information is however required to render their diagnosis more certain and more generally understood.

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[1] Brit. Med. Journal, May 21, 1881.

[2] Op. cit., p. 332.

Hæmato-salpinx not unfrequently complicates the distension of the uterus from retained menstrual fluid, in cases of atresia or obstruction of the uterus, vagina, or vulva. The Fallopian tubes, thus distended, may either rupture or lead to the escape of blood into the peritoneal cavity. Simple hyperæmia of the tube, when part of a general congestion of the sexual organs, may cause either hæmato-salpinx, or the effusion of more or less blood into the peritoneum.

Hydro-salpinx and pyo-salpinx are met with as results of the same causes, all of which excite either catarrhal or suppurative inflammation in the Fallopian tube. The inflammation spreads along the tube to its fimbriated end, and by causing localized pelvic peritonitis, and adhesion of the fimbriæ to the ovary or to the neighboring structures, results in the closure of the distal end of the tube. As the uterine extremity becomes occluded by the same inflammatory process, the tube is thus shut up, and then becomes distended with the secretion poured forth from its lining membrane. It is usually towards the distal or trumpet-shaped end that the chief distension occurs. Occasionally, instead of a simple, elongated, sac-like swelling, several small sacculated swellings form, and the tube then looks more like a loculated pouch.

The mucous membrane of the tube is frequently discolored, and of a blackish-blue, slate, or purple tint. Its ciliated epithelium is desquamated, and the surface assumes a villous condition.

The contents of the distended tube may be either serum, sero-pus, muco-pus, or pus. As the dilatation increases and the mucous membrane undergoes marked changes, the contents may be either thin, watery, and colorless—giving the tube, as Rokitansky describes it, "the appearance of a transparent, sero-fibrous bladder;" or variously colored—of any shade between green, yellow, red, brown, and inky-black—and syrupy, or more or less thick and flocculent. The accompanying particulars of all the cases which have been observed in the post-mortem room of the Middlesex Hospital during the last two or three years, have been supplied to me by my colleague Dr. Fowler. (See Table.) They bring out several important points connected with these pathological changes. The degree of distension varies, but it often attains the size of a goose's egg or larger. The result of these changes in the tube is nearly always to cause matting together of the fimbriated end of the tube, the ovary, intestines, uterus, and pelvic wall. These adhesions are often much contracted and puckered, and, as Bernutz has very fully pointed out and illustrated by numerous cases, other lesions of the pelvic peritoneum are excited by the tubular disease. In some cases, a true purulent cyst is formed by the pelvic peritoneum; in others, a small muco-purulent cyst between the ovary and the tube is met with in the midst of numerous adhesions. Bernutz thinks that the peritonitis is sometimes excited by simple contiguity, and sometimes by the escape of morbid secretions from the tubes into the pelvic cavity. He argues too, with much force and at great length, to prove that these lesions of the Fallopian tubes are the very frequent cause of pelvic peritonitis. Mr. Lawson Tait, referring to a class of cases in which recurrent attacks of severe pelvic peritonitis occur in women in whom distinct tumors, on one or both sides of the uterus, are felt at some examinations, whilst at others no trace of them is detectable, says, "I have so much more frequently found the Fallopian tubes at fault, that I am inclined to believe that in the great majority of these cases of recurrent pelvic peritonitis, due to rupture of a cyst, it is in the tubes that we shall find the origin of the mischief," rather than in the bursting of small ovarian cysts.

CASES OF HYDRO-SALPINX AND PYO-SALPINX IN THE MIDDLESEX HOSPITAL.

Case.	Age.	Hydro-salpinx.	Pyo-salpinx.	Right.	Left.	Double.	Cause of death.	Associated lesions of uterus, ovaries, etc.	Lesions of other organs.
1	29	...	1	...	...	1	Acute peritonitis.	Retroflexion of uterus; abscess of left ovary.	
2	37	1	...	...	...	1	Dropsy.	Submucous fibroid (uterine).	Hypertrophic cirrhosis of liver.
3	32	...	1	...	...	1	Peritonitis.	Uterine fibroid; abscess in left ovary.	Pyelitis, double.
4	45	...	1	...	...	1	Asthenia.	Cancer of uterus, vagina, bladder, and rectum; uterine fibroid.	Cystitis; double hydronephrosis; pulmonary fibrosis.
5	36	...	1	...	...	1	Perforation of bowel: peritonitis.	Endometritis.	Enteric fever; morbus cordis.
6	21	1	...	...	...	1	Œdema glottidis.	Hemorrhage into uterine cavity.	Chronic nephritis; pericarditis; pleurisy.
7	34	...	1	...	...	1	Exhaustion.	Anteflexion of uterus; endometritis.	Scurvy; extensive hemorrhages.
8	54	1	...	...	1	...	Asthenia.	Cancer of left ovary; secondary cancer of uterus; cystic disease of ovaries.	Secondary cancer of right lung.
9	43	1	...	...	...	1	Peritonitis.	Cancer of right ovary.	Annular epithelioma of splenic flexure of colon; secondary growths in liver.
10	32	...	1	1	...	...	Septicæmia.	Rupture of perineum of old date; prolapse of uterus; inflammation and ulceration of vagina and rectum; abscess of right ovary.	Acute pyelonephritis; chronic interstitial nephritis; amyloid disease; parotid abscess.
11	46	...	1	...	...	1	Peritonitis.	Hypertrophy of uterus; endometritis; obliteration of os externum; cystic disease of ovaries.	Syphilis.
12	41	...	1	...	...	1	Peritonitis.	Recent removal of uterine polypus.	Pleurisy; cardiac thrombosis; endarteritis; splenic infarction.
13	41	...	1	...	...	1	Peritonitis.	Peri-uterine abscess; cancer of rectum.	Chronic pleurisy and pneumonia; chronic peri-hepatitis and fatty degeneration of liver.
14	39	...	1	1	...	...	Peritonitis.	Cancer of uterus.	Morbus cordis; fatty liver; kidneys sacculated.
15	21	...	1	...	...	1	Asthenia.	Uterus atrophied.	Ulceration of rectum and ileum, and communication with dilated tubes; general amyloid disease.
Totals		4	11	2	1	12			

Average age in hydro-salpinx, 39 years.
No. of cases of hydro-salpinx, 4 (1 on left side, 3 on both sides).
Average age in pyo-salpinx, 36 years.
No. of cases of pyo-salpinx, 11 (2 on right side, 9 on both sides).

There were recent adhesions in the pelvis in 2 cases of pyo-salpinx.
" " old " " " 9 " "
" " no " " " 1 case of hydro-salpinx.
" " old " " " 3 cases of "

Causes of death in hydro-salpinx—

Dropsy	1
Œdema of glottis	1
Asthenia	1
Peritonitis	1
	4

Causes of death in pyo-salpinx—

Peritonitis	7
Asthenia	3
Septicæmia	1
	11

The condition of the Fallopian tubes was the immediate cause of death in 8 cases of the 15: all these were cases of pyo-salpinx; of these 8, 6 were double, and 2 of the right tube only.

Causes.—Inflammation of the Fallopian tube is a not infrequent result of the puerperal state; it may be caused also by extension by continuity from the vagina or uterus, when these are the seat of catarrhal inflammation or ulceration. It is more than probable that the mischief in some instances arises in the ovary, ovaritis or periovaritis preceding the inflammation of the tube and its adhesion to that organ. Certain it is that abscess in the ovary coexists with pyo-salpinx, as the cases registered by Lawson Tait[1] and Bernutz prove.

In 1880, a woman, aged twenty-nine, who was admitted into the Middlesex Hospital under the care of Dr. Edis, shortly died of acute general peritonitis. At the autopsy, the intestines were found agglutinated and smeared with soft greenish lymph. A very large quantity of pus filled the posterior *cul-de-sac* of the pelvis, and pus was seen to ooze from an abscess as large as a hen's egg, connected with the left ovary. The ovary itself was much swollen, and the Fallopian tube was of large size. The right ovary was twice as large as normal, and its Fallopian tube was dilated. The uterus, except that it was retroverted, was normal in its condition and position, and there were no adhesions about it.

Pelvic peritonitis, from whatever cause arising, may excite tubular inflammation; but probably the sequence of events is more often reversed, the peritonitis being the consequence and not the cause of the inflammation of the tubes. Any sudden check to the menstrual flux is said to give rise to tubal dilatation, as a consequence of tubal inflammation. Morgagni observed that the disease was commonly found in prostitutes, and thought that it explained the frequency of sterility in them. It is possible that the extension of gonorrhœal and leucorrhœal inflammation to the tubes and ovaries is the cause of the condition referred to by Morgagni as occurring in women of the town. Other causes than those above enumerated also exist. I have seen pyo-salpinx in a woman with a procident and ulcerated womb, and a very large hydro-salpinx in one who died of extensive cancerous disease of the uterus. Drs. Wilks and Moxon have met with it in association with chancre in the vagina. Septic metritis and endometritis are also known causes.

Symptoms and Diagnosis.—There is generally a history of long-standing pelvic or peri-uterine trouble, which probably has been referred to inflammation of the peritoneum or pelvic cellular tissue. Menstruation has probably been irregular for a long time: most probably profuse, at too frequent periods, and preceded and attended by considerable pain. Pain, which is more or less constant, as in ovaritis, is greatly increased also by exertion; and is so severe during coitus that all attempts at sexual intercourse cease. Thus in a double manner is sterility induced—by obstruction of the germ-duct and by cessation of sperm-injection. The symptoms do not yield to treatment, either medicinal or mechanical; incisions, dilatations, cauterizations, and the rest of the gynæcological manipulations of the os and cervix uteri being as unavailing as pessaries, leeches, and drugs. Digital examination, vaginal or rectal, will often discover a tender, more or less firmly fixed swelling at the situation of the ovary, or if the tubal affection be double, as it often is, a swelling may be felt on each side. Sometimes distinct fluctuation can be felt in the swelling. Mr. Lawson Tait tells us that the peculiar, sausage-like shape of the distended tube has frequently enabled him to diagnose correctly the presence of hydro-salpinx or pyo-salpinx.[2] On the other hand, the post-mortem room often corroborates the teaching of Bernutz, that the peri-uterine tumors discovered by vaginal examination, are frequently formed by the encysted inflammatory products of the pelvic peritoneum, even in cases in which the tubes are much distended. It may thus happen that a correct diagnosis is based upon wrong premises; and too great reliance on the supposed nature of a peri-uterine swelling, may possibly lead the surgeon astray. The tubal swellings have to be diagnosed from the swellings of pelvic peritonitis, whether these are encysted collections of pus, or masses of viscera matted together. A small ovarian or broad-ligament cyst—especially if fixed by adhesions to the pelvis—or a hydatid cyst in the pelvis, might possibly give rise to confusion. But the more rounded outline of the former, especially as felt through the rectum, and the painlessness of the latter, will assist the diagnosis; whilst either ovarian or hydatid cysts will cause more mechanical interference with the bladder and rectum than do tubal distensions. The examination of the fluid withdrawn by the aspirator will clear up the diagnosis as regards the presence of a hydatid. Between tubal swelling and enlargement of the ovaries from inflammation or abscess, a diagnosis is not possible with our present knowledge. Nor is it of any great moment that this is so, because the same pathological changes are found, and the same operative treatment is required, in each class of cases. To attempt a diagnosis between hæmato-salpinx, hydro-salpinx, and pyo-salpinx, the clinical history and progress of the case must be closely studied. Mr. Tait says that the most common of the varieties of this disease is hydro-salpinx, and the rarest hæmato-salpinx.

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[1] Diseases of Women, 4th ed., pp. 61, 62, 63.

[2] Ibid., p. 65.

Prognosis.—Unless the contents of the Fallopian tubes be removed by the surgeon, or discharged spontaneously through the uterus, or into some coil of adherent intestine, a fatal result must sooner or later occur from pyo-salpinx. Possibly in hydro-salpinx rupture into the peritoneum may occur, and a cure be effected in this way. Probably in some cases of hydro-salpinx and pyo-salpinx there are periodic discharges through the uterus during the catamenial relaxation of that organ, as Dr. James R. Chadwick, of Boston, supposes. If pus escape into the peritoneal cavity, fatal collapse or acute peritonitis will be the end. In other cases, death is brought about slowly by exhaustion from repeated attacks of pelvic peritonitis, and the interference with the functions of important organs by adhesions and contractions of pelvic structures; by the burrowing of pus, the formation of visceral fistulæ, and the septic absorption of decomposing pus and gases contained within the abscesses.

Lawson Tait writes:—

> In its acute stage, inflammation of the tubes is a most formidable disease, and so rapidly ends in general peritonitis that we can hardly recognize the necessity for interfering before it is too late to do anything. I have seen several fatal cases of peritonitis which undoubtedly had their origin from inflammation of the Fallopian tubes, and which ought to have been treated by abdominal section. . . . Pyo-salpinx is, however, a more chronic condition. . . . Probably they all arise in some acute inflammation, which occludes both openings of the tubes, and converts one or both tubes, generally both, into chronic abscesses; yet in the last case I have narrated, there was in the history no incident of an acute kind. Dr. S. Wilks has met with two cases where pyo-salpinx caused general pyæmia, one case proving fatal from an abscess in the liver, the other from an abscess in the brain.[1]

Treatment.—Owing, perhaps, in part to the imperfection of diagnosis, but chiefly to the fact that until lately no serious thought was given to their surgical treatment, these cases have scarcely been submitted to any but expectant and ameliorating remedies. Puncture *per vaginam* for their evacuation has been advised, but much uncertainty as to what the nature of the swelling to be tapped really was, has generally been mingled with the advice. Moreover, tapping has not very often been followed by permanent relief.

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[1] Op. cit., p. 69.

To Mr. Lawson Tait belongs, I believe, the credit of having first shown that complete cure will follow the removal of the uterine appendages; at any rate he has enforced this treatment both by argument and practice, and has thus made himself the advocate of a line of abdominal surgery which is almost certain soon to gain many supporters. Mr. Tait has now removed the uterine appendages for hydro-salpinx no less than twenty-four times, without a single death, and has done the same operation for pyo-salpinx twenty times with uniform success. He, however, warns surgeons that, owing to the adhesions and matting together of the appendages, these operations are the most difficult that he has ever performed—far more difficult than removal of an ovarian cyst with numerous adhesions.

The operation is done by making an abdominal section as for ovariotomy, and then removing the ovaries along with the tubes. Ligatures are used to control hemorrhage, and for the pedicles; the "toilette" of the peritoneum is carefully attended to, as in ovariotomy; and when hemorrhage is severe, or the tube ruptures during the manipulations, or many adhesions have to be separated, the pelvis should be drained for the first few days after the operation.

When owing to the firmness of the adhesions the appendages cannot be removed, the cystic swellings should be exposed by laparotomy and tapped with an aspirator. Then the puncture should be enlarged, and its edges stitched by continuous suture to the edges of the parietal wound, so as completely to close the peritoneal cavity. Mr. Lawson Tait has done this in six or seven cases with ultimate good results; but the process is neither as satisfactory, nor as rapid in its effects, nor as complete in its cure, as the entire ablation of the appendages.

XI. Suppurating Ovarian Cysts.—Suppuration of ovarian cysts, whether as the result of spontaneous or traumatic inflammation, is an infrequent occurrence. Complex multilocular cysts, and those with more or less solid material, are the most prone to suppurate. The size of the cyst has little or nothing to do with the tendency to inflame; for in some cases the patients have been ignorant of the presence of a tumor, until the onset of the acute symptoms, which precede and accompany suppuration, has drawn attention to its existence.

Causes.—It occurs sometimes without any known or traceable cause; but in most instances there is something which has definitely excited suppuration. Failing health, acute intercurrent disease, some neighboring inflammatory affection, the jolting and shaking of a long journey, and blows, falls, or other injuries, are exciting causes. It has been a common opinion that suppuration in an ovarian cyst is almost invariably the result of tapping or some other surgical interference, but this is by no means correct. Keith[1] records five cases in which tapping had not been performed, and in his other cases no symptoms came on in less than five weeks after tapping.

Symptoms.—Suppuration may be acute or chronic. In acute cases the symptoms are abdominal pain and tenderness, often most severe; dry and red tongue, with anorexia; pulse rapid and feeble, from 120–160; rigors and elevation of temperature, varying from 103° to 105° F. at night, and from 100° to 102° F. in the morning; exhaustion, loss of flesh, and profuse perspirations; vomiting and diarrhœa; sallow, shrivelled, and unhealthy countenance, and perhaps putrid discharge from the umbilicus, or elsewhere—all forming a group of symptoms sufficiently characteristic. Often the brain remains clear throughout a long and miserable illness; but in other cases the eyes become dull and vacant, the senses are deadened, and delirium occurs. As regards temperature, though a marked elevation is the common change, Keith has recorded two, and those the most hopeless-looking of all his cases, in which there was striking lowness of temperature: in one the thermometer registered 95.5° to 96.5° F.; yet the contents of the cyst were intensely putrid, and for some days before the operation there had been a steadily rising pulse with the steadily falling temperature; in the other case, the cyst had burst into the peritoneum, and at the time of the operation the temperature was 97° F.; in both these cases the temperature rose within six hours after the removal of the tumor, in the first from 95.5° to 97° F., in the second from 97° to 100.5° F. Keith remarks: "The statement, that, when there is pain or tenderness, this generally arises from inflammation of the peritoneal surfaces, requires modification; the reverse is oftener the case. Tenderness or pain, if long continued, is almost always a certain sign that irritation is going on in the tumor somewhere. Simple surface-tenderness causing surface-adhesion, rarely lasts long; and the worst cases of adhesion met with have often no history of either pain or tenderness." If tapping is performed, the cyst rapidly refills, and typhoid symptoms are prone to come on, sometimes with great rapidity. In chronic cases there may or may not be general tenderness or pain. There may be no rise of either pulse or temperature, and the general state of health may be fairly good, or even apparently robust. On the other hand, pain on walking or moving may be sufficient to cause the patient to keep her bed for many months.

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[1] Edinb. Med. Journal, February, 1875, p. 686.

In one of Keith's cases a very severe attack of inflammation occurred, and the tumor had existed during at least one pregnancy, yet every symptom of irritation, pain, and tenderness had subsided some months before the operation.

Diagnosis.—In acute cases, and in the advanced stage of suppuration, there is no difficulty in diagnosing the condition by the symptoms above enumerated. In chronic cases, and in the early stage of suppuration, the diagnosis is most obscure. When the temperature is low, the surgeon may be thrown completely off his guard, and may suspect neither inflammation nor suppuration. From acute and suppurative pelvic peritonitis, and from acute pelvic cellulitis and abscess, these changes in ovarian cysts may be distinguished by the following characters:—

(1) Ovarian tumors have an abdominal as well as a pelvic portion, the latter being in most instances in front and to one side of the displaced uterus. (2) The uterus though displaced backwards and to one side, is yet not fixed by peri-uterine induration. (3) The tumor presents a more or less globular outline, and obscurely fluctuating resistance.

From pelvic peritonitis, an inflamed ovarian tumor is further distinguished by the very mild character of the peritonitis, and generally by the unaltered size and outline of the swelling after the peritonitis has subsided.

Prognosis.—When left to themselves, suppurating ovarian cysts almost invariably end sooner or later in death. Occasionally the cyst bursts into the vagina, bladder, rectum, or some higher part of the bowel, or externally, and then if the cyst be unilocular, recovery may take place after many months of illness and suppuration. Much more frequently, however, the patient dies of exhaustion, hectic, or septicæmia, after tapping or bursting of the cyst; or the cyst ulcerates or bursts into the peritoneum, and collapse or acute general peritonitis kills the patient; or if the cyst is not tapped and does not burst, the patient dies from the pressure and dragging effects of the tumor, that is, from dyspnœa, syncope, uræmia, vomiting, diarrhœa, or intestinal obstruction.

Very rarely the cyst when inflamed shrinks, and so much diminishes in size as to become unnoticeable; but this does not happen if the cyst suppurates. Years after the spontaneous discharge of pus and blood from an ovarian tumor, fresh inflammation may be lighted up in the remains of the cyst. Such was probably the course of events in a case described by M. Goupil,[1] in which a tumor burst and discharged *per vaginam*, when the girl was in her eighteenth year; at twenty-nine a violent attack of pain was followed by metrorrhagia, and at thirty-three a tumor existed in the right hypogastrium, continuing painful for one month, and then subsiding in size under treatment.

Treatment.—Until comparatively recently, these cases had been left to the merciless course of the disease; or at best, attempts to give temporary ease from pain and distension by tapping, had been made. As a step in advance of simple tapping, free incision and drainage were adopted, and a few cases in which this practice was followed recovered. Incision and drainage have been made through the abdominal wall, through the vagina, and through the rectum, the first being the best; but few women are strong enough to bear the exhausting suppuration which goes on under these circumstances, sometimes for many months.

In December, 1864, Keith, of Edinburgh, performed ovariotomy upon a woman in a state of semi-delirium from septic fever, for a very large suppurating tumor.[2] His remarks thereon are so striking that I must quote his own words: "This was probably the first time that surgery broke in upon an acutely inflamed peritoneum. The intense lividity, amounting almost to blackness, of the abdominal contents, and the spongy tenderness of inflamed intestine, were then strange to me, though thought little of now. Recent lymph was present everywhere; adherent bowel and mesentery hedged in a thick-walled cyst, the base of which was in a complete state of slough. Inflammation had gone on to gangrene, and there was intense putridity. After an operation which went on for two hours, the patient was placed in bed, cold, vomiting, and nearly pulseless. It seemed as if we had simply killed her, yet she got rapidly into heat, the restless delirium at once disappeared, there were warm perspirations, much sleep, and a recovery without a drawback."[3]

In February, 1875, Keith contributed his classical article to the Edinburgh Medical Journal, and it marks a most striking era in the history of ovariotomy. Therein he records seven cases of acute suppuration of ovarian tumors which he had submitted to ovariotomy, and he tells us that up to that time he had operated in the same way upon ten acute and two chronic cases, and that in all save two of the acute cases the patients recovered. This result was obtained against what seemed to be very desperate odds; and in one case the cyst had actually ruptured into the peritoneal cavity, yet recovery followed the operation. In all these cases, where the temperature was very high before, there was a fall of several degrees within a very few hours after the operation. In only one of the acute and one of the chronic cases were there no adhesions; in others the adhesions were of the gravest nature, and the operations were tedious and severe. Indeed, Keith says of them—

> "To an onlooker, few operations look so hopeless as those for the removal of acute suppurating cysts. The general condition is always unfavorable, and as a rule ovariotomy is in these circumstances tedious and severe. To be believed in, such cases need almost to be seen." Yet he concludes (p. 687), "The extreme feebleness of pulse and depression of the vital powers, which all cases of acute suppurating cyst present, must not deter one from operating. Hopeless without interference, they are not the unfavorable cases for operation that they seem, or, judging from the small number of reported successful results, have hitherto been regarded."

Ovariotomy in such cases must be, of course, followed up by the most scrupulous attention to the cleanliness of the peritoneum, before closing the abdominal incision, and drainage through the lower angle of the wound is necessary. In a case of multilocular ovarian cyst jammed within the pelvis, and universally adherent to its viscera, pus escaped from one of the cysts during removal, and afterwards two or three others were found to have suppurated. A drainage tube was not introduced into the abdomen, but a thin, blood-stained serum escaped for three or four days from the lower angle of the ovariotomy wound. The patient made a good recovery, somewhat retarded though by an abscess in the abdominal wall. There was nothing prior to the operation to indicate the existence of suppuration in any part of the cyst.

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[1] Bulletin de la Société Médicale d'Observation, 1856.

[2] This case was reported fully in the Lancet, 1865.

[3] Edin. Med. Journal, Feb. 1875, p. 674.

Hydatids.

A *hydatid*, or, in other words, an echinococcus-cyst, is the larval form of a tapeworm—the *Tænia echinococcus*—which infests the upper intestines of dogs and wolves, and consists of not more than three joints. The formation of a hydatid cyst in man is very slow, and results only from the ingestion of the tapeworm eggs, which are swallowed with the food or drink; impure water, to which dogs have access, is a very common vehicle for these eggs in their passage to the human stomach.

A hydatid tumor consists of (1) a thick, gelatinous, elastic, gray, translucent bladder, having a laminated, hyaline structure; this is the *ectocyst* of Huxley; (2) a thin, delicate, soft, but not very elastic, membrane, lining the ectocyst, and having usually upon its inner surface crowds of minute bodies like white grains; this is the germinal membrane, the *endocyst* of Huxley, and it is, moreover, the essentially vital part of the echinococcus-cyst or "bladder-worm," as the hydatid is also styled; (3) very minute buds or gemmæ which are produced by the endocyst, and remain for a time attached to it by means of a stalk, either singly or in groups, and are covered by a thin, delicate sac continuous with it; these buds are the minute, white grains seen on the inner surface of the endocyst, and they develop into *scolices*, or *echinococcus-heads*, which are the embryos of the Tænia echinococcus, and which have the anatomical characters of the head of the tapeworm; the double circlet of hooklets, and the four oval suckers placed at regular intervals outside the hooklets, together with the head that carries them, may be seen either protruded from, or retracted within the little sac with which the head is continuous; (4) a quantity of clear watery fluid which distends the endocyst, and within which float numerous vesicles of various sizes, some of the smallest being still adherent to the germinal membrane. These vesicles are the secondary or daughter echinococcus cysts; and many of the larger contain a third, and these again a fourth generation. Dr. T. S. Cobbold, F.R.S., in a letter which he has written to me upon this subject, says: "The production of daughter and grand-daughter hydatids by proliferation or budding, has given rise to much controversy. Leuckart holds that these secondary formations ordinarily take their origin at different points between the lamellæ of the ectocyst. Naunyn, on the other hand, holds that the daughter-vesicles are special bud-developments of the endocyst. I think that the process as observed by Leuckart is exceptional: that the vesicles are abnormal scolices developed from buds of the endocyst; with Naunyn, I hold that the endocyst is primarily concerned not merely with the production of echinococcus-heads, but also with the formation of the secondary and tertiary hydatids, whether exogenous or endogenous. In other words, and in agreement with the views of Von Siebold, Wagener, and Bremser, it is thought that the secondary or daughter bladders are, for the most part, either metamorphosed or imperfectly developed scolices, which, in their turn, may give rise to true heads."

The fluid in which these vesicles float is limpid and alkaline, of specific gravity 1007–1009, containing no urea, and but a trace of, if any, albumen; the presence of a large quantity of common salt, causes it to throw down a copious white precipitate with a solution of nitrate of silver. It may contain echinococci, or the hooklets of the echinococcus-heads, or shreds of the equally characteristic striated hydatid-membrane; but even without these structures, the hydatid fluid is distinguished by its chemical composition from every other fluid which forms in the body.

Outside the ectocyst there is commonly an investing capsule of greater or less thickness, derived from the inflammatory products found in the tissues in which the hydatid has implanted itself. This adventitious capsule adheres intimately to the organ or structure in which the tumor occurs, and is very freely supplied with blood.

Sometimes the hydatid cyst is barren, that is, there are no echinococcus-heads developed upon the endocyst, but fluid alone is contained within it. These barren cysts are aptly called *acephalocysts.* They are the form of hydatid cyst most readily cured by tapping. The various changes which hydatids may undergo will be referred to when speaking of hydatids of the liver. They may occur at any age, and in either sex, and are not limited to any particular organ, structure, or part of the body, but have been occasionally found in each one of them. The most common situation is somewhere within the abdomen; and the organ by far the most frequently invaded is the liver. In the large majority of cases where they have infested other parts and organs, they have originally occurred in the liver. Hydatid cysts may exist for years without destroying life, and even without being detected or suspected.

HYDATID CYST OF THE LIVER.—*Symptoms.*—The origin, and, for a time, the progress, of a hydatid of the liver are insidious, and it is not even suspected to exist until a perceptible tumor occurs. The tumor, when first detected, may be not larger than an orange, but it may grow to such a size as to fill the greater part of the abdomen. The natural outline of the liver is changed by it as it grows in an upward, downward, or lateral direction. The surface of the tumor is smooth and regular, unless, as occasionally happens, two or more distinct cysts project from the surface of the liver near together, and thus present a lobulated outline. The tumor is elastic, if not actually fluctuating. If there be none, or but a thin layer, of the liver-tissue overlying the cyst, fluctuation will be distinct, and a thrill or vibration indicative of fluid will be detected on palpation. The hydatid's growth is slow, and when found to be of large size, it has probably existed for years—perhaps for very many years.[1] Except from its weight, and the effects of pressure on surrounding parts, or from the embarrassment it causes to the breathing, it gives rise to no local inconvenience until it occasions inflammation of the peritoneum covering it, when attacks of acute pain and tenderness occur. Such attacks are not, however, common in hydatid disease. Œdema of the lower limbs, hemorrhoids, enlargement of the superficial veins of the abdomen, and ascites, are exceptional symptoms, but they are met with; and when they exist their cause is the pressure of the tumor upon the vena cava and vena portæ. Jaundice is rarely caused by hydatid of the liver, and, when present, it arises from one of three conditions, namely, pressure on the bile-duct, rupture of the cyst into the duct, or catarrh of the ducts. In rare cases the splenic vein may be engorged, or the ureter compressed,[2] by the hepatic cyst; or either the spleen or kidney may be simultaneously the seat of a hydatid; otherwise the spleen is not enlarged, nor is the urine altered. Though the patient's health may be impaired through the functional disturbance of some neighboring viscus, the tumor does not excite fever or other constitutional irritation, and does not even materially disturb the proper functions of the liver.

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[1] Bright, Budd, Murchison.

[2] Bright, Clinical Memoirs on Abdominal Tumors, etc.

Diagnosis.—The diseases which are most liable to be confounded with hydatid of the liver, are hepatic abscess; distended gall-bladder; cystic, and medullary, or other soft, solid tumors of the kidney; and effusion into the right pleural cavity. Aneurism and ascites may also possibly give rise to doubt. A large, simple cyst of the liver would be almost, if not quite, indistinguishable from a hydatid cyst of that organ; but then such simple cysts are very rare, whereas hydatid cysts are comparatively quite common.

(*a*) The slow and insidious character of its growth, and the absence of pain and constitutional symptoms, would serve to exclude abscess. If, however, the hydatid cyst should become inflamed, and suppurate, it would present all the local and constitutional characters of abscess, and the diagnosis would then depend alone upon the clinical history and the previous long existence of a fluctuating, painless swelling in the hepatic region. The prognosis and treatment in each class of cases would be the same.

(*b*) The shape and position of a distended gall-bladder, its usual mobility in a lateral direction, and the fact that its development is commonly preceded and accompanied by attacks of biliary colic, and frequently by jaundice, will point to its exclusion. It must, however, be remembered, that a hydatid cyst of the liver may be pendulous, and that the gall-bladder may become distended without attacks of colic or pain of any sort. A case is related[1] by Dr. S. F. Simmons, of a tumor occupying chiefly the left side of the abdomen of a woman; it was diagnosed to be a distended gall-bladder, but on post-mortem examination it turned out to be an enormous hydatid cyst, containing sixteen pints of hydatids of various sizes.

(*c*) Cystic and soft solid tumors of the kidney generally first present themselves in the loin, or if on the front of the abdomen, then lower down than the hepatic region. In their early stage, there is often a line of resonance between them and the liver dulness. Sometimes there is evidence in the urine of changed kidney structure and function, but its absence does not at all exclude tumor of this organ. I have seen, in several cases, cystic and solid tumors of the kidney without any sign of renal disease having been furnished by the urine; and soft, solid tumors of the kidney, mistaken for hepatic cysts, which have given the elastic if not fluctuating sense of fluid, and which have been aspirated without result. The rapidity of growth and the marked impairment of health in medullary cancer, sarcoma, and tuberculous disease of the kidney, will serve to distinguish those affections from a hydatid.

(*d*) Effusion into the pleura, attended with bulging of the ribs and intercostal fluctuation, might be suspected to be present, but a physical examination of the chest and the absence of constitutional symptoms would serve to indicate the hydatid nature of the swelling. In great pleuritic effusion the liver is pushed down, in hydatid enlargement the lung is pushed up. Hydatid of the liver may, however, cause, or coexist with, the pleuritic effusion.

The pain, pulsation, and bellows-murmur caused by aneurism of the abdominal aorta, and the same symptoms, together with jaundice, which are caused by aneurism of the hepatic artery; the constitutional cachexia, and the tender, hard, and uneven surface of the liver in cancer of that organ—would assist in distinguishing those diseases. In ascites, the parts of the abdomen which are dull on percussion are the lowest in position, and vary with posture; this is not so in hydatid of the liver, even when the cyst is of enormous size. If ascites and hydatid of the liver coexist, the detection of the latter may be quite impossible until the ascitic fluid is removed. Finally, the hydatid character of a tumor will be at once made certain by an examination of the fluid withdrawn by the aspirator.

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[1] Med. Communications, vol. i. page 101. London, 1784.

Prognosis and Modes of Termination.—Hydatid tumor of the liver may last for years without causing trouble, or without its presence being detected until after death. Its existence is compatible with perfectly good health; but after it has once attained a size large enough to be recognized, or to give rise to symptoms, if it be not cured by treatment it will go on growing, though possibly very slowly, until it bursts or causes death by the effects of its pressure. I have the notes of several such cases (detected only after death) from the post-mortem registers of the Middlesex Hospital, in which no indication of the hydatids' presence existed during life; none of these cysts, however, were larger than an orange or cricket-ball. Murchison taught that spontaneous cure was "confined for the most part to tumors of so small a size that they are not recognized during life;" and the notes now before me of cases taken from the Middlesex Hospital records, since the time when Murchison was one of the physicians of that hospital, entirely corroborate this statement.

By its pressure, the tumor may excite a fatal pleurisy, pneumonia, or peritonitis; by its rupture, various consequences follow, dependent upon the direction in which it bursts. If into the pleura, acute pleurisy and death are the almost invariable results; and this is the commonest direction, and on the right side only, rarely on the left, is the pleural sac invaded. When the lung becomes adherent to the diaphragm prior to the giving way of the tumor, the contents may escape into the bronchial tubes and be expectorated, and the patient may recover; on the other hand, he may die from gangrenous pneumonia, exhaustion, or pyæmia. Rupture into the pericardium is always, and rupture into the peritoneum nearly always fatal. Bright[1] mentions a case which is possibly one of recovery after rupture into the peritoneum, and Ogle, one of recovery after rupture into the omentum.[2] Rupture of the cyst into, after adhesion with, the stomach or intestine, is the most favorable termination, but it is not very common; in these cases the hydatids are slowly vomited or passed *per anum.* Death may, however, occur from exhaustion, peritonitis, hemorrhage from the sac, or multiple hepatic abscess.[3] The cyst, after having formed adhesions with the parietes, may ulcerate and discharge externally at the umbilicus, or in some other part of the abdomen, or in one of the lower intercostal spaces. Though such cases do not commonly end in recovery, several are on record as having done well; in others the patients have died from peritonitis, hemorrhage from the sac, or prolonged suppuration from its walls. It is not very uncommon for a hydatid cyst to open into the bile-ducts[4] or gall-bladder, and thus to occasion obstruction of the bile, and, as a consequence, jaundice and biliary colic. The entrance of bile into the cyst kills the parasite, and either leads to the withering up of the contents and spontaneous cure of the tumor, or lights up fatal inflammation and suppuration in its walls. In very exceptional cases such a cyst has opened into the vena cava, and caused instant death by impaction of some of its contents in the pulmonary artery. Death may be caused by the accidental rupture of a cyst within its bed. I have had such a case in my own practice:—

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[1] Op. cit., New Syd. Soc. ed., p. 47.

[2] Trans. Path. Soc. Lond., vol. xi. p. 295.

[3] Dr. Owen Rees, Med. Times and Gazette, June 20, 1857.

[4] Trans. Path. Soc. Lond., vol. xvi. p. 160, and vol. xix. p. 256.

A boy, in good health, and not known to have any hepatic symptom whatever, fell, striking his belly upon a fender. He died almost directly from shock. At the post-mortem examination there was found a simple hydatid cyst in the right lobe of the liver, the size of an orange; the cyst had been in part detached from its bed in the liver, and there was a laceration one inch long in the surrounding liver-tissue. Blood had been effused into the cavity of the cyst; the liver capsule was intact.

Blood effused between the adventitious cyst and the hydatid cyst is occasionally a cause of death. Again, death may be caused in various ways besides by the rupture of the cyst: (*a*) By the effects of pressure on the stomach, ureter,[1] great bloodvessels, etc. (*b*) The tumor may attain such a size that it nearly fills the abdomen and interferes with respiration and the heart's action, as well as with the functions of the abdominal viscera, and so death is caused by exhaustion and marasmus. (*c*) The cyst may suppurate and the case terminate fatally from pyæmia. (*d*) Secondary hydatid tumors are apt to form, either in the liver or some other organ of the abdomen or chest, or in the brain, and then lead to death by the pressure or inflammation which they excite.

Abortive Terminations of Hydatid Tumors.—It has been stated that some of these tumors undergo so-called "spontaneous cure;" this means that the hydatid fluid is absorbed, that the vesicles burst or shrivel up, and that the contents generally are converted into a putty-like material, whilst the cyst-wall calcifies or thickens into a tough, leathery, or cartilaginous membrane. The contents of these withered cysts are not always of the same appearance: sometimes they are of creamy whiteness, and like cream-cheese; sometimes of a transparent yellow, or lemon color, having the appearance and consistence of calf's-foot jelly. Under the microscope, abundance of fat-globules and plates of cholesterine are to be seen, and generally shreds of the laminated hydatid-membrane, or hooklets of the echinococci, are to be found amongst the altered cyst-contents, though this is not always the case.

I have notes of a case in which the cyst compressed the vena cava, vena portæ, and common bile-duct, was the size of an orange, and was situated at the portal fissure. This cyst contained a clear hydatid fluid, but its walls were in places cartilaginous, and in others hard and coated internally with calcareous plates. The patient had died of phthisis. The causes of these various changes are either the calcification of the parent-cyst, or the overgrowth of one of the daughter-cysts leading to strangulation from within; or the entrance of bile into the cyst. It is possible that some intercurrent disease may interfere with the well-being of these parasites, and so lead to their abortive ending. I have notes of three cases of death from phthisis, in which shrivelled tumors of size varying from that of an egg to that of a cricket-ball, were found on post-mortem examination.

Treatment.—This resolves itself into the prophylactic and the surgical. Medicines are quite powerless to effect any influence upon a hydatid tumor. The ova of the Tænia echinococcus develop not only in man, from whose body they do not as a rule pass, but also in sheep, from whose bodies the echinococci are again set free in the slaughter-house, to be devoured by dogs and again developed into tapeworm. *Prophylaxis*, therefore, as Murchison has pointed out, is based on a knowledge of these facts, and consists in preventing dogs from feeding on offal, or frequenting slaughter-houses, and in thoroughly boiling all "dog's meat;" further, the tapeworms generated in dogs should be destroyed by periodically physicking the dogs, and burying or burning their excreta. These measures are of national importance in countries, such as

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[1] See Case I., p. 17, in Dr. Bright's work on Abdominal Tumors.

Iceland, where the sheep-dog nightly occupies the same room as his master. In Iceland, hydatids are the cause of one-seventh of the human mortality.

The *surgical treatment* consists either in evacuating the fluid contents of the cyst by a fine trocar and canula, or an aspirating needle; or in the evacuation of the whole of the contents of the cyst by a large and free opening.

Puncture.—The evacuation of the fluid of hydatid, as well as of simple cysts of the liver, has long been recommended and practised by English physicians and surgeons,[1] several of whom have pointed out that when a fine trocar and canula are used, and care is exercised on withdrawing the canula to keep the abdominal parietes gently pressed back against the liver, there is no necessity to wait for adhesions between the cyst-wall and the abdominal parietes before resorting to operation. Experience has shown that, in a large proportion of cases, the removal of the thin and limpid liquid of a hydatid tumor is sufficient to destroy both the parent and daughter cysts. Moreover, the safety and efficiency of the operation are amply proved. The experience of this treatment at the Middlesex Hospital over a period of many years, has been highly successful, as the cases recorded by Murchison and Greenhow show. Greenhow has put on record two cases of tumor of large capacity, from which 110 and 148 fluidounces were drawn off in this way, and in each of which a cure was obtained. I can from my own experience bear testimony to the efficiency of simple tapping with a small aspirating trocar and canula: in three cases a single tapping, and in another a single repetition, effected what seemed to be a perfect cure. The operation should be performed in all cases in which the tumor is visibly increasing: the inducements to evacuate the contents under these circumstances are twofold, viz., (1) to prevent the risks of rupture, either spontaneous or traumatic; and (2) to relieve discomfort, and to obviate the injurious effects of pressure and weight upon neighboring organs.

The mode of operating is as follows: The patient being in the recumbent position in bed, a puncture into the most prominent part of the cyst is made with a fine trocar and canula, connected or not with an exhausting syringe, or aspirator. The fluid is thus evacuated, but before withdrawing the canula the surgeon must make sure that there is nothing plugging its opening and preventing the escape of some remaining fluid; this is done by simply moving the end of the canula within the cyst, if the aspirator is being used, or by passing a fine wire through the canula, if it is not connected with an aspirator or exhausting syringe. On withdrawing the canula, the punctured parietes are pressed against the cyst so as to avoid dragging them apart, and thereby allowing the fluid in the canula to drop into the peritoneal cavity. The puncture is covered with a piece of absorbent cotton-wool and collodion; a large soft compress of cotton-wool is placed upon the liver, and a flannel bandage is applied over the compress and around the trunk. Strapping should not be used: it is less comfortable to the patient, and, by not yielding to the respiratory movement and to the constantly varying size of the abdomen, drags upon the skin and exerts too much pressure. When employed merely to retain a thick, elastic layer of cotton-wool, there is less objection to it. The patient should be kept in the recumbent posture for thirty-six hours, and all manipulation on the part of the medical attendant, and all unnecessary movements of the chest and abdomen on the part of the patient, should be strictly forbidden. An anæsthetic is rarely needed, and is best avoided, lest vomiting should be excited. If the patient is very sensitive to pain, or very nervous, the ether spray may be locally applied. There is rarely any subsequent pain or uneasiness, but if there is, an opiate should be given. As a rule, the evacuation of the fluid is followed by immediate relief from the sensations of weight and tension; but in many instances, after a week or ten days, the liver enlarges again, owing to some inflammatory effusion around and within the cyst-wall. This enlargement may increase for a week or ten days; but afterwards the inflammatory products are slowly absorbed, so that swelling should not lead to a hasty repetition of the tapping. The inflammatory changes are indicated by the character of the fluid which is withdrawn if a second puncture is made—this fluid being of a higher specific gravity, turbid, and containing albumen, and even a tinge of blood. It is no proof of an unsuccessful result of tapping, that some degree of fulness remains for many months in the situation of the tumor, because, as the operation, though it kills the hydatid, does not remove the parent-cyst and secondary vesicles, time must be allowed for them to undergo atrophy.

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[1] Hawkins, Med.-Chir. Trans., vol. xviii. pp. 167–171; Brodie, ibid., p. 119; Bright, op. cit., p. 42; Budd, Med. Times and Gazette, May 19, 1860, p. 494; Murchison, Diseases of the Liver; Greenhow, Trans. Path. Soc. Lond., vol. xvii. p. 127.

It sometimes happens that the sac refills with fluid, and in this case the secondary enlargement does not subsequently diminish, but on the contrary increases until the swelling again feels elastic or fluctuates. Under these circumstances a repetition of the tapping is requisite.

The dangers of tapping are (1) acute peritonitis, from the escape of some of the hydatid fluid into the peritoneum, and (2) suppuration of the cyst. An altogether exceptional risk is illustrated by a case recorded by Mr. Bryant,[1] in which sudden death followed the puncture of a single hydatid cyst, owing to the perforation of the trunk of the portal vein which had been displaced forwards and upwards by the tumor. Blood escaped into the cyst and peritoneum; but death was attributed not to the hemorrhage, but to the escape of some of the hydatid fluid into the portal vein.

With due care on the part of the surgeon and absolute quietness on the part of the patient, these risks are not great, and there are several cases on record to prove that peritonitis is not by any means necessarily set up by the escape of the hydatid fluid into the peritoneal cavity.[2]

It is quite unnecessary to wait for the formation of adhesions between the cyst and parietal peritoneum; nor should any steps be taken to induce them. The elasticity of the walls is sufficient to close the opening made by a small instrument. No irritating substance, such as alcohol or iodine, should be injected into the cyst after withdrawing the liquid; it is not requisite for the purpose of killing the parasite, and it is prone to excite dangerous inflammation in the cyst. In some cases in which puncture has seemed to cure the tumor, the patients have returned after months or years with a cyst as large as ever, and in some instances in a state of suppuration. It is undeniable that in some of these cases the original cyst has refilled; but it is equally certain that in others the recurrent tumor is due to the growth of a fresh cyst, which may or may not have existed in a small and unrecognized form at the time of the operation.

Puncture is not contra-indicated either by the great size of the tumor, or by the presence of some amount of irritation in it. The latter condition suggests a risk of suppuration, but good recoveries have followed puncture in both classes of cases.[3]

There are two conditions however in which a free incision should certainly be employed instead of puncture, namely: (1) when the cyst's contents are very largely composed of daughter-cysts instead of fluid, and, (2) when suppuration has already set in. The presence of a large proportion of secondary cysts cannot with certainty be foretold; but perhaps the rapid growth of the tumor, pain whilst the tumor is yet small, and absence of fluctuation and thrill, are the most suggestive symptoms of this condition. If, on tapping, the quantity of liquid which escapes is much less than the size of the cyst would lead one to expect, the inference is that the daughter-

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[1] Trans. Clinical Society, vol. xi. p. 230.

[2] See paper by Dr. Fagge, Med.-Chir. Trans., vol. liv.; and paper by Dr. Duffin, Trans. Clin. Soc., vol. vi.

[3] Greenhow, loc. cit., vol. xviii.; Duffin, loc. cit. vol. vi.

Cases of Hydatid Tumor of Liver Treated

Year.	Name.	Age.	Sex.	Married or single.	History.	State on admission.
1870	E. C.	29	F.	Marr'd	....	Multiple hydatids of peritoneum.
1871	C. M.	45	M.	Single	Till 1857 enjoyed good health; he then first discovered a tumor over the liver. Two years ago he noticed another tumor over umbilical region; no pain in either tumor.	Multiple hydatids of liver and omentum.
1871	T. C.	29	M.	Marr'd	....	Hydatids of liver; hepatic dulness measured 9½ inches.
1874	E. J.	29	F.	Marr'd	....	Admitted with all the signs of pleurisy with effusion on the right side; the liver enlarged and pushed downwards. Subsequently pleuritic friction was heard on the right side, and the liver dulness extended. Vomiting and pain in abdomen followed. Shortly after this a visible bulging was noticed over liver. The liver dulness increased in every direction.
1875	A. H.	23	F.	Single	Patient has had a dull pain in region of umbilicus for 6 weeks. Her attention was called to it by a swelling in that region four days ago.	Hydatid of liver. Suppurating and discharging at umbilicus.
1876	C. T.	49	F.	Marr'd	7 years ago, when stooping, felt sudden pain in abdomen. She afterwards noticed a lump the size of a hen's egg. 5 years ago the tumor was tapped; 6 months ago the swelling began to enlarge again.	A prominence seen in the left epigastric region, corresponding to the left lobe of the liver. The swelling was smooth and elastic; dull on percussion.
1877	J. M.	35	M.	Single	Patient has had pain in the right side for 3 years. There was bulging in the right mid-axillary line. At Royal Hospital, City Road, a small puncture was made and some purulent fluid withdrawn; subsequently paracentesis was performed in 8th space, and some fluid containing cyst-walls removed.	....

cysts are numerous, and suppuration may be expected. The state of health of the patient, the size of the cyst, the admission of air, inquisitive manipulation after tapping, and any roughness or injudicious movement, may excite suppuration; but of all conditions the two in which puncture is most likely to be followed by the formation of pus, are, when the tumor is of large size, and when there is a large proportion of secondary cysts.

IN THE MIDDLESEX HOSPITAL SINCE 1870.

Treatment, with dates.	Result.	Stay in hospital.	Post-mortem report.
....	Discharged at own request.	8 days.	
....	Relieved.	12 days.	
....	Discharged at own request.	51 days.	
The girth of the abdomen having increased, the tumor was tapped on April 9, and 46 oz. of purulent fluid withdrawn, containing a number of hydatid cysts. A gum-elastic catheter was introduced, and the cavity washed out. The canula was retained. The liver after tapping returned almost to its normal size. April 19, the tube was removed, and matter allowed to drain through the wound. The cavity was washed out daily. The opening closed in 24 hours after the tube was removed.	Convalescent.	72 days.	
....	Recovered.	130 d'ys.	
Sept. 7. The tumor was tapped and 24½ oz. of straw-colored fluid withdrawn. The fluid was found to contain cholesterine scales, fat globules, and albumen.	Discharged at own request. Much improved.	27 days.	
On admission a small incision was made over seat of puncture of a few days ago, and a large trocar and canula introduced. Nothing escaped through this, and a probe when introduced was found to enter a large smooth cavity, a depth of about eight inches. When the probe was withdrawn, opaque and transparent membranous shreds of a jelly-like consistency escaped, but not sufficiently fast, so a large incision was made, and the cavity cleared out and washed out. A drainage-tube was inserted. The cavity was washed out daily, with increasingly less discharge. He left the hospital with a catheter in, but on showing himself again on Jan. 7, 1878, the tube had then been out for a fortnight, and the opening had quite closed with a depressed cicatrix. The bulging in the side had entirely disappeared.	Cured.	77 days.	

Cases of Hydatid Tumor of Liver Treated

Year.	Name.	Age.	Sex.	Married or single.	History.	State on admission.
1877	C. F.	58	M.	Marr'd	....	The liver dulness began at lower border of 6th rib in front and 9th behind, and extended vertically 7½ inches; in the middle line it reached to the umbilicus. Above, its upper border corresponded to xiphoid cartilage, and on left it reached nearly to mammary line. An inch above the umbilicus, to the right of the middle line, was an ovoid swelling, tender and ill-defined, measuring about 3 inches upwards and outwards, reaching to within an inch of first floating rib. The swelling was elastic and fluctuating.
1878	W. S.	38	M.	Marr'd	Ten weeks ago was taken with severe twisting pains in abdomen.	The abdomen was very tense and tender, especially in epigastric and hypochondriac regions. May 11, the abdomen was very tense and dull on percussion, right across. The swelling was semi-fluctuating. May 22, there was a distinct prominence in the epigastric region.
1879	S. M.	26	F.	Single	Four years ago was ill for 14 days with sickness, loss of appetite, and headache; not jaundiced; 6 days ago was attacked with vomiting; no abdominal pain; at the same time she noticed her eyes were yellow and urine high-colored.	Liver dulness began in mammary line at 5th rib, in axillary line at 5th interspace. It extended to costal arch below, and measured 5 inches in nipple line, and 3½ in parasternal line. Abdomen was somewhat distended.
1879	W. H.	58	M.	Marr'd	24 years ago had jaundice. After he was well of that, a small lump formed on his right side; this disappeared, but came out again in lower part of right back; this burst and left an open, non-discharging wound for six months. 12 years ago he had a small tumor the size of a horse-bean in the lower part of the right side of chest, which has gradually increased till now. 4 years ago he felt as if something had given way inside him, followed by sickness and diarrhœa. This was followed by hepatic tenderness, and a month after he was jaundiced.	The liver dulness began above at nipple level, and extended vertically downwards about 7 inches. Just to the left of the middle line was an elastic, rounded tumor, with ill-defined edges; it moved with respiration; it seemed to protrude from under left costal arch. The right border of the tumor reached to the middle line. It measured transversely 5⅛ inches, and vertically 4½ inches; no fluctuation could be obtained.

IN THE MIDDLESEX HOSPITAL.—*Continued.*

Treatment, with dates.	Result.	Stay in hospital.	Post-mortem report.
Oct. 18. Tumor was tapped, and ½ oz. of blood-stained and somewhat milky fluid drawn off, containing flakes and granular-looking shreds of membrane. On the 23d he got jaundice. The tumor was then again aspirated, and only 3 oz. of fluid withdrawn. It was then freely incised, and a quantity of fluid with collapsed cysts escaped. A drainage-tube was inserted. On the 25th the tube was removed, and the wound left to heal, it having been washed out daily. By Nov. 15 the wound had healed, but the tumor had reformed. Nov. 17, the tumor was again opened, and only a small quantity of sanguineous fluid withdrawn. The discharge from the wound then became very free and in character that of pus. He had also developed a cough with offensive sputum. The discharge gradually became more profuse.	Death.	54 days.	The right lobe of the liver was found to be almost entirely replaced by 3 large cysts ; 1 emptied by paracentesis ; another fill'd with daughter-cysts ; a third was suppurating, and had made its way into the lower lobe of right lung. Kidneys granular.
May 24. A trocar was inserted into tumor, and only a small quantity of blood withdrawn. The abdomen continued to swell, and vomiting set in after this ; also œdema of both legs and hands.	Death.	41 days.	The right lobe of the liver was almost entirely occupied by a large suppurating hydatid cyst which had perforated through the diaphragm into the right pleura, causing empyema and compression of the lungs.
July 4. An exploratory puncture was made with a hypodermic syringe 2 inches below the scapula, and a few drops of pale, clear fluid and air withdrawn. July 14. The swelling was aspirated between the 9th and 10th ribs. Then a free incision was made, and 43 oz. of pus and gelatinous, brownish-colored membrane let out. A drainage-tube was inserted. July 29. The wound was irrigated with a solution of tincture of iodine ʒj–Oj.	Death.	80 days.	There was a fistula in 9th interspace leading to a nearly empty hydatid cyst in right lobe of liver. There were abscesses elsewhere in liver. A quantity of semi-inspissated pus in right pleura. Compression of lung with lines of interlobular pneumonia.
Sept. 24. The tumor was explored with a fine trocar and canula. Some broken-down granular material with large cells containing nuclei escaped. Oct. 2. The tumor was again aspirated and small pieces of semi-transparent membrane were removed. Oct. 4. The patient anæsthetized, and a small incision was made in the seat of the old puncture, and a curved trocar and canula inserted into tumor. On withdrawing the trocar some unbroken hydatid cysts and pieces of membrane came away. The canula was left in ; the next day tubing replaced the canula, and the cavity was washed out with a solution of sulphurous acid ; he, however, shortly afterwards developed peritonitis.	Death.	31 days.	Deep jaundice ; fistulous opening in right hypochondrium ; liver adherent to parietes. Abscess beneath right lobe, and numerous small cysts full of pus and shreds of membrane in the left lobe. Other small cysts scattered in liver. Gall-bladder and main duct distended with clear fluid. Kidneys granular and bile-stained.

Cases of Hydatid Tumor of Liver Treated

Year.	Name.	Age.	Sex.	Married or single.	History.	State on admission.
1880	C. A.	39	F.	Marr'd	14 years ago had a lump in her right side. 10 years ago was operated on for hydatid of liver in King's Coll. Hospital, and again the following year. Six years ago was operated on at St. Bartholomew's.	The right hypochondriac region occupied by a prominent swelling reaching to umbilicus; 2½ inches below xiphoid was a sinus discharging pus. The tumor moved with respiration, was firm, non-elastic, and non-adherent to skin.
1881	J. T.	29	M.	Single	Five years ago had some pain over liver. Had not noticed any swelling. Was at work till 3 days ago.	There was considerable bulging in right hypochondrium. The swelling moved with respiration. The liver dulness began at nipple level, and extended to umbilicus. The liver dulness extended across the middle line to left hypochondrium.
1881	J. P.	41	M.	Single	17 years ago had jaundice in India. At that time he noticed a swelling in epigastrium which remained painless till 9 months ago.	The liver dulness commenced at 5th rib in mammary line, and extended to an inch off the umbilicus; on the left side it merged on splenic dulness. It measured 8 inches vertically. There was a large oval swelling in epigastrium. It moved with respiration; a faint wave could be obtained at upper part. The tumor was firm, hard, and a little irregular.
1881	A. C.	14	M.	Single	Patient has had pain in his right side for about a month.	Liver dulness commenced at 6th rib, and reached to half an inch from umbilicus. The dulness extended across to the left side, verging into cardiac. The swelling occupied the epigastrium and right and left hypochondriac regions, the greatest prominence being just below costal margin. Tumor moved with respiration; firm, and non-fluctuating.
1881	A. H.	29	F.	Single	7 years ago was treated for hydatid of liver. 6 weeks ago felt sharp pain in right hypochondriac region.	The liver did not extend below the ribs, but there was a distinct bulging on the left side in the lower axillary and infra-mammary region, which she had noticed for three years.
1882	E. H.	29	F.	Single	12 months ago noticed that her ribs began to grow out after a fall; a swelling formed, and has gradually increased in size.	Liver dulness normal. The left hypochondriac region was occupied by a globular swelling. It was elastic, and moved with respiration. Its area of dulness was continuous on the left side with that of the spleen, and on the right with that of the liver. The lower edge well-defined, and could be felt.
1882	M. L.	32	F.	Marr'd	2 years gradually increasing swelling in hepatic region.	Liver dulness increased downwards on right of median line. There was a globular outline to swelling.

Free Incision.—A certain proportion of failures must be expected to follow simple puncture. Murchison's table shows that out of 46 cases in which the operation of simple tapping was performed, 35 appear to have been quite successful. In 10 cases the operation was followed by suppuration, necessitating a free opening, and in these, 8 patients recovered and 2 died. In neither of the two fatal cases did death seem to be caused, or indeed hastened, by the operation. In one case the patient succumbed to peritonitis within twenty-four hours after the puncture. Dr. John Harley,[1] who advocates a large and

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[1] Med.-Chir. Trans., 1866, vol. xl. Dr. Harley has again urged the value of a free opening, and described his method of procedure, in a paper in the 12th vol. of St. Thomas's Hosp. Reports, 1883.

IN THE MIDDLESEX HOSPITAL.—*Concluded.*

Treatment, with dates.	Result.	Stay in hospital.	Post-mortem report.
Tumor incised. Cavity washed out with carbolic acid through wound, coming out through fistula. Cavity washed out daily.	Cured.	32 days.	
Feb. 2. Tumor tapped, half an inch below costal cartilages, and 27 oz. of clear, watery fluid removed, which contained some cysts.	Cured.	56 days.	
June 3. Tumor tapped, only pure blood evacuated. During his stay in the hospital the liver dulness remained the same. The tumor had become harder.	Not improved.	71 days.	
July 5. Tumor tapped; needle first entered solid substance and then the cyst, and 25 oz. of clear watery fluid drawn off. The tumor shrank visibly. July 9. Swelling again appeared. Aug. 10. Tumor tapped; 1½ pints clear, watery fluid drawn off.	Relieved.	70 days.	
Nov. 9. Tumor aspirated in most prominent part, and 46 oz. of clear fluid withdrawn.	Cured.	10 days.	
Aug. 31. A hypodermic syringe was thrust into the most prominent part of the swelling, but no fluid was withdrawn. The tumor from that day gradually got less prominent, although the area of dulness remained the same.	Discharged at own request.	22 days.	
Tapped twice with aspirator, 25 and 18 oz. being drawn off. Fluid slightly turbid, contained well-marked echinococcus hooklets.	Left without trace of tumor.	26 days.	

permanent opening in preference to a small puncture, gives a mortality of 10 out of 35 cases of puncture; but Murchison has pointed out that Dr. Harley's table "throws an illegitimate discredit" upon the operation in question.[1] A former student at the Middlesex Hospital—Dr. Mortimer Balding—in his graduation thesis for the degree of Doctor of Medicine, of Cambridge, 1880, collected 267 cases of hydatid cyst of the liver; of these the character of the fluid at the first tapping is given in 155. Out of these 155 cases the fluid was clear in 106, and in 49 it was more or less thick, purulent, or tinged with bile. Out of the 106 cases in which clear fluid was drawn off at the first puncture, there were 86 cures, 17 deaths, and 3 in which the results are unknown. Moreover, there is no evidence that suppuration ever took place in 71 of the 106 cases, and of these 71 cases 58 were cures, 11 deaths, and 2 unknown as to results. In the 49 cases in which the fluid was not clear on the first puncture, 26 patients were cured, and 20 died, the results in 3 cases being unknown.

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[1] Murchison, Diseases of the Liver, 1st ed., p. 112.

The inference is, that if the fluid is not quite clear at the first puncture, if suppuration sets in after the first puncture, or if no improvement follows puncture when the contents of the cyst consist largely of daughter-cysts, the proper plan of treatment is, either to introduce a very large trocar and canula, and leave the canula in, or, what is still better, to make a deliberate incision into the cyst, and stitch the edges of the cyst or liver to the edges of the parietal wound. To delay operating in one of these ways, after pus has fairly formed, is to court disaster by long and exhausting illness, if not by early death. The medical attendant should, therefore, carefully watch for the signs of suppuration.

In making an incision we need not fear wounding a non-adherent peritoneum. The operation should be thus performed: an incision should be made through the abdominal parietes over the most prominent part of the cyst, until the liver-capsule is reached, all bleeding from the cut surfaces being arrested, however, before the peritoneum is opened; a trocar and canula should then be introduced into the cyst, and all the fluid drawn off, taking care that none of it escapes into the peritoneal cavity; this can be insured by having a long canula, or by packing sponges around it, before withdrawing the trocar. Next, an incision with a narrow-bladed bistoury should be made into the cyst, using the canula as a guide. If adhesions have not formed between the cyst and the parietes, care must be taken to seize and draw forwards the edges of the incision into the liver-cyst, and they should be stitched by continuous suture to the edges of the incision in the abdominal parietes. Sir Joseph Fayrer has devised a grooved canula for opening liver-abscesses, which is well adapted for hydatid cysts; the canula is of medium size, and would empty the cyst of fluid and small vesicles, and its groove would then serve as a guide for the bistoury. After emptying it of its contents, the cyst should be washed out with a weak solution of iodine, Condy's fluid, salicylic acid, or some other antiseptic; a drainage-tube should be inserted, and the opening covered with boracic charpie, or cotton-wool, and over that a layer of carded oakum. Subsequent daily dressings and irrigation will be required for a longer or shorter time, according to the amount and character of the discharge. I have opened hydatid cysts of the liver in this manner on five or six occasions, and have been surprised at the slight amount of bleeding which has followed incisions, deep and wide through the liver tissue, made in order to fully lay open the interior of the cyst; and even when hemorrhage has, for the moment, been free, it has soon stopped upon using gentle pressure. A source of danger from bleeding lies, however, in rough attempts to tear out the parent-cyst. Such an attempt should never be made. Bright[1] relates a case, in which, the cyst having opened and discharged spontaneously just below the umbilicus, an effort was made to pull away the cyst-wall. The next day severe hemorrhage set in, and at the post-mortem examination an open hepatic vein was found, from which the bleeding had occurred. Though it is right to remove at once all the secondary cysts from its interior, the parent membrane should be left to become loosened, or to slough, and then large masses of it will escape in the subsequent dressings.

The chief dangers after free incision, are exhaustion from protracted discharge, pyæmia, and secondary abscesses. The best security against these contingencies is early operation. That the mortality hitherto has been nearly fifty per cent., and that many of the successful cases have recovered only after a long and exhausting illness, is largely due to hesitation and procrastination before having recourse to the operation. The preceding table (page 1048) contains most, if not absolutely all, of the cases which have been under treatment in the Middlesex Hospital, since the termination of the late Dr. Murchison's connection with it. The cases therein contained show the advantage of operative treatment, by either simple tapping or incision. When the treatment has failed, it has been because failure of tapping has not been followed up by free incision; or because a second or third, deeper-placed cyst has burst into the peritoneum or lung; or, finally, because the cyst has existed a very long time, and jaundice and its other ill effects have been produced before the case has come under treatment at the hospital.

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[1] Op. cit., p. 50.

The influence of Cruveilhier,[1] Récamier,[2] Bégin,[3] and others, who used to insist on the necessity of adhesions before operating upon hydatid cysts and abscesses of the liver, and who resorted to tedious and harmful methods to obtain these adhesions, did much to retard the adoption of a better line of treatment. The same fears do not trouble the surgeon of to-day; and it is much to be regretted that the remarks made by Dr. Wm. Thomson, in 1841, in his learned and practical treatise on "Diseases of the Liver and Biliary Passages," were not earlier acted upon by surgeons generally. Dr. Thomson says:[4] "The observations already made in respect to opening of abscesses, seem to show that the apprehensions about exploratory punctures of aqueous or hydatid cysts of the liver are exaggerated; and perhaps, also, to suggest the expediency of an operation being performed in this class of cases at an earlier period than has heretofore been usually practised."

Treatment by Electrolysis.—Dr. Hilton Fagge and Mr. Durham employed electrolysis in the treatment of eight cases of hydatid tumor of the liver.[5] Two needles were connected with the negative pole of a modified Daniell's battery of ten cells; the positive pole was connected with a moistened sponge. The needles were introduced into the cyst, and the sponge was applied to the surface of the abdomen. The current was continued for a period varying from ten to twenty minutes at a time; and the treatment was continued over a period varying from two to four or five weeks. Besides the eight cases in Fagge's list, one other, recorded by Playfair,[6] should be added; all the nine patients did well, and recovered; but it must be added, that the tumors were small, and in young subjects. Dr. Fagge suggested two alternatives of the *modus operandi* of electrolysis, (1) leakage from the cyst into the peritoneum or elsewhere, (2) the direct action of the electrolytic current. In four out of the eight cases observed by Dr. Fagge, fluid did leak into the peritoneal cavity, and once it leaked into the pleura. In two, if not in three cases, leakage, it is presumed, did not occur. The operation was generally followed by slight febrile symptoms and some pain; but these symptoms usually passed away in a few days.

It has been already stated that hydatids may occur in any part or organ of the body; and may originate in, invade, or encroach upon, any abdominal organ. Wherever one exists it will indicate its presence, if at all, first by the occurrence of swelling in the region of the abdomen occupied by the organ affected, and then by interfering by its pressure with the functions of the particular organ, or of some other important structure in its neighborhood. Bearing these facts in mind, what has been said respecting hydatids of the liver holds good of similar tumors of the kidney, spleen, omentum, etc. I shall therefore dismiss the subject of hydatids of the other abdominal and pelvic organs in a very few words.

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[1] Dict. de Méd. et Chir. Prat., Art. Acéphalocystes.

[2] Rev. Méd., tome iii. p. 436. 1827.

[3] Journ. Hebdom., tome i. p. 417. 1830.

[4] Op. cit., p. 244.

[5] Med.-Chir. Trans., vol. liv.

[6] Ibid.

Hydatids of the Gall-bladder.—Walther says[1] that he once met with hydatids in the cavity of the gall-bladder; but he regarded this as an unique morbid condition.

Hydatids of the Spleen.—The recognition of the hydatid nature of the tumor will rest upon the same evidence as in hydatid of the liver; but the diagnosis as to whether in any particular case the cyst is in the spleen, left lobe of the liver, or left kidney, will be based on the same objective symptoms as in cases of other swellings in the left hypochondrium. This is often excessively difficult, and in the cases in which the fluid contained in the cyst presents cholesterine, and is found to give the play of colors with nitric acid suggesting the presence of bile,[2] confusion is almost sure to be caused. Generally, however, a hydatid tumor of the spleen extends too far back in the left hypochondrium and left loin to be mistaken for a growth in the left lobe of the liver. The absence of all renal or vesical irritation would help to exclude the kidney, but would not absolutely do so.

The *treatment* should be based on exactly the same principles as have been described under the heading of hydatids of the liver.[3]

Hydatids of the Kidney.—In some cases no symptoms exist, in others, besides the presence of a renal tumor, there may be attacks of renal colic, followed by the discharge of hydatid vesicles *per urethram.* Hydatid cysts of the liver, it should be remembered, have sometimes discharged themselves into the pelvis of the kidney. If a renal cyst enlarges it is apt to be mistaken for an ovarian cyst, and patients have been operated upon under this erroneous diagnosis.

A renal hydatid cyst may burst into the pelvis of the kidney, or into the intestine, or peritoneum, or lung. Suppuration may occur either before or after a puncture has been made, and then fever and lumbar pain set in as a rule.

The *diagnosis* is made certain if, when the history and situation of a tumor suggest the kidney as its seat, hydatid vesicles are passed by the urethra.

The *prognosis and treatment* are the same as in hydatid of the liver—with this reservation, however, as respects prognosis: that hydatids of the kidney, as of the spleen, are very often secondary to hydatids of the liver.

Hydatids of Mesentery and Omentum.—Hydatid tumor in either of these parts occurs occasionally, either alone or in conjunction with hydatid of the liver.

A woman, aged 45, who had jumped out of a window, was admitted into the Middlesex Hospital under my care, with a number of fractured bones. She died, and at the post-mortem examination there was found a rounded hydatid tumor, the size of a small melon, in the substance of the mesentery. The capsule of the cyst was of dense, cartilaginous hardness, and the contents were a semi-fluid, caseous mass, of a pale-yellow color. The walls of the cyst were covered internally with calcareous plates. This was a case of spontaneous recovery of a hydatid of the mesentery.

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[1] Annot. Academ.

[2] See paper by Habershon, Guy's Hosp. Rep., 3d series, vol. xviii. p. 384.

[3] For details of cases of hydatid of the spleen, see Bright, Clinical Memoirs on Abdominal Tumors; Habershon and Hilton Fagge, Guy's Hospital Reports, 3d ser., vols. xiv. and xviii.; Bristowe, St. Thomas's Hospital Reports.

Dr. Wickham Legg[1] has recorded a case of hydatid cyst within the omentum. The cyst was full of daughter-cysts, and was adherent to the sigmoid flexure of the colon; there were, besides, three cysts in the liver, and another, the size of a child's head, between the rectum and bladder. Death was caused by prolonged jaundice due to pressure of one of the hepatic cysts upon the hepatic duct.

Murchison[2] reported two cases in which numerous hydatid cysts had grown in the mesentery, omentum, and other parts of the peritoneum. In one case certainly, and in the other doubtfully, the disease commenced in the liver.

Hydatid tumors in these processes of the peritoneum, if large enough to be detected, present smooth, elastic, painless, movable swellings. If they are numerous and growing, or if single and of very great size, there will be paroxysmal attacks of abdominal pain, vomiting, dyspnœa, and faintness; and possibly ascites and other evidences of intra-abdominal pressure. The tumor will be lobulated or uniform, according as there are several cysts, or only one cyst.

Tapping, or the removal of the cysts by laparotomy, must be resorted to for relief or cure. Though it may be found impossible to remove all the cysts when multiple, relief from distension will be afforded by puncture; and life will be prolonged, and the patient temporarily improved, by the evacuation of several of them.[3]

Hydatids of the Abdominal Parietes.—Hydatids occur in the subcutaneous areolar tissue, in the muscles, and in the cellular tissue between and beneath the muscles of the abdominal walls.

Mr. Bryant[4] has recorded a case of an enormous tumor beneath the muscles, but apparently outside the peritoneum, which had been growing fourteen years, and had throughout been regarded as an ovarian cyst. It was tapped in the eighth year of its existence, when seven pints of thin fluid were drawn off. Subsequently it attained the size of a pregnant womb at full time, and a second cyst, the size of half an orange, developed beneath the skin, midway between the pubes and the umbilicus. Mr. Bryant removed the smaller, and laid open the larger cyst, from which many quarts of hydatids and fluid escaped. The edges of the wound in the cyst were stitched to the edges of the external wound by five or six sutures, an opening three inches in length being left. The patient had quite recovered in sixteen weeks. Mr. Bryant remarks, that this large tumor, when kneaded, gave rise to a special and peculiar sensation, due to the rolling and pressing together of the immense and closely packed mass of secondary (daughter) cysts, and he thinks that this might help to indicate the nature of a similar case.

Hydatids between the Bladder and the Rectum.—Several cases of hydatid tumor in this situation are recorded. Dr. Legg's case above alluded to, and cases recorded by Dr. Bright, are good instances.

The usual symptoms caused by hydatids in this situation are difficulty in defecating and micturating, with pain in the penis, groins, and over the lower part of the abdomen, and œdema of one or both of the lower limbs. A smooth, elastic swelling will in all probability be felt *per anum*. In a case recorded by Mr. Bryant, the post-mortem examination of which I made with my friend Mr. De'Ath, of Buckingham, the bladder was pushed quite high up out of the pelvis, and in the direction of the left hypochondrium. There had been long-standing urinary troubles, and retention at last became complete. Dr. Bright[1] gives two cases of hydatid in this situation, in one of which there was incontinence of urine, and a tumor, giving the appearance of vesical distension, presented itself above the pubes, and flattened the otherwise unaltered bladder.

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[1] Trans. Path. Soc. Lond., vol. xxv. p. 160.

[2] Ibid., vol. xxiii. p. 126 *et seq.*

[3] Ibid., vol. xxiii. p. 128.

[4] Guy's Hosp. Rep., 3d ser., vol. xiv., p. 235.

When discovered during life, as they most likely will be owing to the symptoms they excite, these cysts should be evacuated by puncture or incision, if they cause inconvenience or distress. In a young woman under my charge, there was a large elastic swelling between the rectum and the uterus and vagina, causing much local and constitutional disturbance. A quantity of fluid was withdrawn by a puncture with a trocar and canula, passed into the cyst through the vaginal wall. Benefit was immediate, and the cure apparently permanent, for on readmission for another cause a year afterwards, there had been no reaccumulation.

CYSTS OF THE ABDOMINAL VISCERA.

SIMPLE, WATERY, OR SEROUS CYSTS OF THE LIVER.—These cysts occur either in the substance of the liver or just beneath its peritoneal covering. They may be either single or multiple, simple or multilocular, and may originate either by the dilatation of a biliary duct, or possibly by the expansion of a hepatic cell; or again by a new development altogether. Though not uncommonly existing of a small size, they sometimes attain very large dimensions, and encroach upon the diaphragm and surrounding abdominal organs. Generally they displace the intestines backwards, and therefore when they have grown so as to nearly fill the abdomen, and when their course and clinical history are not well known, they are liable to be mistaken for ovarian cysts. This mistake and the reasons for it are well illustrated in a case recorded by Dr. Ward Cousins.[2]

The inner surface of these cysts exhibits the general characters of serous membrane, and the outer surface, when not imbedded in the substance of the liver, is covered with a layer of condensed cellular tissue of greater or less thickness. They contain a limpid, saline fluid, differing from hydatid fluid by being coagulable by heat, alcohol, and acids. They grow slowly and painlessly, until by their great size they press upon important structures or organs. Many pints of fluid, even two or three gallons, have been removed from some of these cysts, and when they have attained to this size they cannot be diagnosed from unilocular ovarian cysts except by close attention to their clinical history. When of much smaller size they move freely within the abdomen, are noticeable as being connected with the upper part of the abdominal cavity and as therefore growing downwards, and are sometimes spoken of as "floating tumors." Yet from renal tumors they may be distinguished by the fact that *right* renal swellings have the ascending colon in front and to the inner side of them, and that *left* renal swellings have the descending colon crossing their front surface, whereas these hepatic swellings are as a rule in front of the bowels. From hydatid cysts it is impossible to distinguish them except by the characters of the fluid which they contain. From a perusal of a number of cases collected and recorded by Mr. Cæsar

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[1] Op. cit., p. 40.

[2] Brit. Med. Journ., Dec. 5, 1874, p. 700.

Hawkins,[1] one is driven to the conclusion that most if not all those which were grouped by him as "aqueous encysted tumors" of the liver, were in reality simple hydatid cysts, that is, hydatid cysts with aqueous contents, and no daughter-vesicles. It must be remembered that in 1833, when this paper was published, the exact anatomy of a hydatid cyst, and the chemical and microscopical characters of hydatid fluid, were not as well known as they are now. Prof. Gross[2] removed from a delicate woman, aged twenty-three, nearly a gallon and a half of fluid as clear as spring water. No recurrence followed. When an aqueous or simple serous cyst is not wholly inclosed by liver substance, but is projecting from its edge, or more or less pedunculated and hanging from its under surface,[3] the distension of its walls may in time become so great as to lead to its rupture and to the discharge of its contents into the peritoneum; or after the formation of adhesions the cyst may spontaneously burst on the surface, or into a hollow viscus. Under certain circumstances the lining membrane of these cysts is apt to inflame and suppurate, so that they become converted into abscesses.

Treatment.—As soon as the cyst has attained to any uncomfortable size, or if there is any danger of its bursting into the peritoneum, it should be punctured in the same way as a hydatid cyst; and if it quickly refills it should be opened, and its edges should be stitched to the edges of the wound in the abdominal parietes. When a serous cyst attains a large size, it is prone to form anterior adhesions which may be difficult to break down, or which may bleed or ooze freely after separation; moreover, it cannot be determined in advance whether the cyst is pedunculated or in large part imbedded in the liver. These are reasons for not attempting complete extirpation. If, however, laparotomy has been performed on a mistaken diagnosis, and the cyst is easily separable from its adhesions, and fairly well protruded from the liver, there is no reason why, after it has been evacuated, the bulk of the cyst should not be cut away, and the remaining part stitched to the upper end of the abdominal wound.

My colleague, Mr. Hulke, has recorded a case of multiple dermoid cyst attached to the surface of the liver. It occurred in a woman who died of cancer of the uterus. Similar dermoid cysts were found connected with the ovary.

True cystic disease of the liver, in which the whole organ is more or less studded with small, if not minute, cysts, is generally found associated with similar disease (cystic degeneration) of the kidney. This form of cystic disease of the liver has no special surgical importance.

Simple or Serous Cysts of the Kidney.—Distinct from that form of cystic distension of the whole organ which results from obstruction in the ureter, and which is commonly known as hydronephrosis; distinct also from that rare form of disease in which the whole kidney is converted into a mass of conglomerate cysts—some of which hold several ounces of fluid, the septa between which are mere relics of granular renal substance, and in which the cystic masses are eight or ten times the normal size of a kidney—and which always proves fatal; and distinct, too, from the cysts of small or microscopic size met with in great numbers in the "granular kidney," there are simple cysts frequently seen in the kidneys of elderly people, one or more of which may attain considerable size, and so constitute a disease of great importance. In our museum at the Middlesex Hospital, are some beautiful specimens of this form of cyst, though none of them are, perhaps, of a size to have formed a noticeable tumor during life. In the Hunterian Museum there are also specimens, and the Transactions of the London Pathological Society contain some cases scattered through its volumes.

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[1] Med.-Chir. Trans., vol. xviii.

[2] System of Surgery, 6th ed., vol. ii. p. 634. 1882.

[3] See Dr. Cousins's case, loc. cit.

These simple cysts arise in the cortex of the organs, and project in relief from its surface, the rest of the kidney being healthy and functionally active. Sometimes, however, a communication is established between the cysts and one of the calyces of the kidney. The contents of the cysts are fluid, the fluid containing a small quantity of albumen and a little saline matter, but rarely, if ever, any urinary ingredients. Rokitansky was never able to discover in them even a trace of urinous precipitates or concretions. Dr. Wm. Walter[1] records a case of cystic tumor in a floating kidney for which nephrectomy was performed. The cyst contained 10 ounces of a pale, straw-colored fluid, of specific gravity 1013, containing $\frac{2}{5}$ albumen, but no urine. The walls of the cyst were very thin and tense, and of transparent, bluish hue. In Mr. Cæsar Hawkins's case of "Aqueous Encysted Tumor" of the kidney, the transparent fluid of the cyst contained no albumen, which suggests its possible hydatid nature; but Dr. Prout wrote of it, "the fluid is *serous*—I have not detected anything urinary in it."[2] If hemorrhage has taken place into the cyst-cavity, owing to the giving way of some bloodvessel in its walls, the fluid will have a sanguineous color and character. Moxon states, that very often these cysts contain a thick jelly-like matter, like thin glue, and at other times nearly solid, which resembles the colloid matter found in other parts of the body. The origin of these cysts is uncertain; possibly they arise from the conversion of the cellular layer in the Malpighian corpuscles into serous cysts, or from the dilatation of tubes or Malpighian capsules, or perhaps, from vacuolation of epithelium. But, however this may be, we know that cysts of different origin, and even of varying microscopical structure, may secrete fluid contents which are chemically and physically alike. Simple renal cysts commence insidiously, grow slowly, present themselves first in the loin, or in the lumbar area of the front of the belly, and may be so hard at first as to be mistaken for solid growths. As they increase, they gradually monopolize the greater part of the abdominal cavity, their point of attachment ceases to be even approximately ascertainable, and they may give rise to the idea of ovarian tumor when they occur in the female. Hemorrhage may take place into them; and cancer has been developed in their parietes. As they grow, they tend to spread out the renal substance, so that a good part of the kidney may be stretched in a thin layer over the attached part of the cyst-wall. Rokitansky once found such a cyst of considerable size, and seated at the circumference of a kidney, inflamed and ruptured, its contents having escaped into the surrounding adipose tissue. The following case,[3] which came under my own observation, affords an illustration of several of these points:—

A man aged 69, who had enjoyed good health till two and a half years previously, came under treatment for a swelling the size of a cricket-ball, situated to the left of, and somewhat below the umbilicus; it gave him no pain; he had had no injury; his urine was for a time albuminous, and once or twice contained a little blood; the tumor slowly increased, and was prominent, firm, globular, not fluctuating, and appeared more like a fibrous tumor of the abdominal wall than an intra-abdominal swelling. There was no dulness in the loin. Nine months afterwards (August, 1869), the tumor occupied the whole of the left half of the abdomen, and reached somewhat over to the right side of the median line; it fluctuated distinctly and in all parts, and was fairly movable in every direction, though the abdominal parietes were tightly stretched over it. During this and the two or three preceding months, the patient had had several attacks of syncope, which occurred generally after taking exertion, or after eating his midday meal. Eleven months subsequently (July, 1870), the tumor occupied nearly the whole abdomen, and projected forwards, and had the characters of an ovarian tumor. Fluctuation was distinct; emaciation and debility were extreme; there was no albumen, blood, or pus, in the urine. The man died on October 4, 1870, worn out by the distension and pressure of the tumor. He would not have done so, however, had I known then, as I do now, how to treat renal cysts. At the post-mortem examination, a large cyst was found springing from the left kidney, projecting forwards the peritoneum, and pushing the small intestines, which were quite free from the tumor, downwards into the right iliac and pelvic regions. The transverse and descending colon were adherent to the tumor by their meso-colon, and formed an arch over and towards its posterior aspect. The tail of the pancreas and lower end of the spleen were adherent to the back of the cyst. The left kidney occupied a nearly transverse position in the loin; its upper half was normal, but the rest was spread out in a thin layer over the base of the cyst. In this expanded portion was a second, small, transparent cyst, the size of a currant. The capsule of the kidney was continued over the cyst. The pelvis of the kidney was unaltered, excepting for the drag upon the calyces of that part of the kidney which was spread out over the cyst. The cyst weighed sixteen pounds, and measured, after it had been contracted in spirit, twenty-nine inches in its longitudinal and twenty-six inches in its transverse diameter. It was filled with a dirty-brown fluid, and with coffee-ground colored blood-clot. Some of the clot had been deposited in irregular strata, but some recent hemorrhage had also occurred. The cyst-wall varied in thickness, but averaged about one-eighth of an inch; large veins passed over its posterior surface, and branches of the renal artery and vein were traced into its substance. Two small nodules of medullary cancer were seen in the left kidney, and several in the lungs and liver; the right kidney was small, and contained several cysts varying in size from that of a pin's head to that of a pea, or larger. There was thus no difficulty in explaining the attacks of syncope during life; the large quantity of blood-clot in the cyst had clearly been derived from some of the branches of bloodvessels upon and in the cyst-wall. The cancer was a mere accidental coincidence in the case, and had probably been induced by the depraved state of health—the result of disturbed functional activity of the abdominal viscera—caused by the pressure of the tumor.

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[1] Brit. Med. Journ., September 29, 1883.

[2] Med.-Chir. Trans., vol. xviii. p. 186.

[3] Trans. Path. Soc. Lond., vol. xxii. p. 171.

Dr. Bristowe[1] has recorded a case of doubtful origin, but which he regarded as a hemorrhagic cyst of the spleen, kidney, or peritoneum. It was cured by repeated tapping, and the evacuation, on the first occasion, of a gallon and a half of opaque, dark, reddish-brown fluid. This case was, most probably, one of simple cyst of the kidney, into which hemorrhage had occurred. The disease commenced with obscure abdominal symptoms, followed before long by an abdominal tumor, which rapidly increased until it formed a large, ovoid, somewhat irregular swelling, occupying the left side of the belly, and extending from the ribs above to the pubes below, and from the left loin to two inches or so to the right of the median line. The patient rapidly emaciated and got weaker, vomited, and suffered from intense abdominal pain coming on in paroxysms. His general aspect (he was a young man) was precisely that of a woman in the last stage of untreated ovarian dropsy, or of a child sinking from the effects of a malignant tumor of the kidney. The abdominal tumor was the only evidence of disease in the body. The large intestine did not appear to cross the front surface of the tumor.

The difficulty in the *diagnosis* of such cysts will be apparent from the reports of the above cases. The symptoms excited are merely those of pressure, and are, therefore, like the symptoms of other cystic swellings—hydatids, or cysts of other structures. The locality of the tumor in its earlier stages will somewhat aid the surgeon in correctly judging of the organ affected; but not even then in estimating precisely the character of the swelling. In Bristowe's case, in its symptoms, position, and cure by repeated tappings, the tumor resembled some of those false cysts which are formed by adhesions after rupture of the kidney or liver, and which have been described in previous sections. My own case, in its early days, was most like one of solid inter-mural tumor; and afterwards, like Bristowe's, might have been, if in a woman, mistaken for one of ovarian disease. The relative position of bowel to ovarian cyst, as compared to that of bowel to renal tumor, would not have assisted to a differential diagnosis in either instance. Nor did the character of the urine. Bristowe, in the same number of the Lancet, records another case which shows the difficulty of diagnosis and somewhat resembles his first case. The second, however, on post-mortem examination, turned out to be one of round-celled sarcoma, growing from amongst the pelvic viscera, and containing a large, hemorrhagic cyst. The cyst was tapped five times, fluid of a reddish-brown color, alkaline reaction, and specific gravity 1024, being drawn off in quantities varying from seventy-four to one hundred and sixty-seven ounces. Thus the difficulties which surround the diagnosis of these very rare cysts are extremely great, for not only may they be mistaken for hydatids of the kidney, hydronephrosis and other tumors of the kidney, and perinephric fluid collections; but it is, moreover, almost impossible, after using every care in examination, to distinguish them, sometimes from solid tumors in the parietes, sometimes from hepatic or splenic cysts, or cysts of the omentum, mesentery, or pancreas, sometimes from malignant cystic tumors springing from the pelvis or elsewhere within the belly, and sometimes—indeed, generally, in their later stages—in the female, from ovarian cysts.

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[1] Lancet, May 5, 1883 (case also previously published in St. Thomas's Hosp. Reports).

The *treatment* of these cysts is the same as the treatment of hydatid cysts of the kidney, and of hydronephrosis and pyonephrosis. As soon as they have attained such a size as to cause inconvenience, they should be tapped, and if they refill again and again, they should be cut down upon, either in the loin or on the front or side of the abdomen, according to the indications in the particular case; and after drawing off the fluid the cyst should be cut into, and the edges of the cyst stitched to the edges of the parietal wound. Under these circumstances the cyst will collapse, and either with or without suppurating, will probably close. If a fistula should remain and prove troublesome, the question of nephrectomy may be considered; but it must be borne in mind that the kidney structure in these cases is functionally useful, and therefore the organ ought not to be sacrificed without specially strong reasons.

Renal cysts of Congenital Origin.—Renal cysts, like hydronephrosis, are sometimes congenital, and lead to enormous abdominal distension of the fœtus in utero. Parturition is sometimes thus rendered difficult, or even impossible, and the child when born presents the appearance of one having an ovarian cystic tumor. Cystic degeneration, with abdominal distension, is a cause of death of the fœtus in utero, or during birth; and it is sometimes found associated with various malformations, such as talipes, cleft palate, and imperforate anus.[1]

Cysts of the Spleen.—Cysts, other than hydatid, are very rare indeed in the spleen. Large simple serous cysts of this organ have been occasionally met with. M. Péan successfully removed a hypertrophied spleen containing a large cyst. The *symptoms* would be those due to pressure, and would not differ from those caused by serous cysts of the kidney or other organs. In the early stage, their *diagnosis* would be attended with all the difficulties which attend that of renal cysts, and in their later stages there would be the same resemblance to ovarian cysts. The *treatment* should at first consist in aspirating the contents, and, if the cyst should refill, the same treatment should be adopted as has been recommended for other abdominal cysts. Splenectomy, unless obstinate suppuration occur, or hypertrophy of the organ complicate the cyst, as in Péan's case, can seldom, if ever, be requisite or justifiable.

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[1] See cases reported in the Transactions of the London Obstetrical Society; and a paper of mine in the Proceedings of the Royal Medical and Chirurgical Society of London, for 1876.

Cysts of the Pancreas.—Though the pancreas is, rarely, the seat of a hydatid cyst, the common cause of cysts in this organ are such as give rise to obstruction of the pancreatic duct. Calculous concretion in the duct, is by far the most frequent cause of cystic dilatation; but any other obstacle to the free escape of the pancreatic secretion will produce the same result. Thus cancer of the duodenum, a gall-stone impacted at the lower end of the common bile-duct and pressing upon the orifice of the pancreatic duct, marked induration of the pancreatic tissue, or peri-pancreatic adhesions, especially those which tend to displace the pancreas, are possible causes of cystic formations. Dilatation of the ducts of the pancreas, whether sufficient to constitute a large cyst or not, is a very frequent result of the impaction of pancreatic calculi. From the analogy of these distension-cysts with the cysts of the salivary glands, Virchow has given them the name of "Ranula pancreatica." Mr. Joshua Parsons made the same comparison in 1857, in his report of a case of pancreatic cyst which will be mentioned hereafter. As in the case of the ureter, the pancreatic duct, if the obstruction is complete and near its bowel-end, may become dilated throughout; and the accessory or branch ducts may present the appearance of diverticula opening into the duct of Wirsung. From local interstitial inflammation, or catarrh of the lining membrane, or from a plug of mucus, one of the smaller ducts alone may be affected, while the main duct remains pervious.

The cysts of the pancreas vary much in size and form. In some cases, the cyst-wall is thick, tough, fibrous, cartilaginous, or even osseous: the inner surface may be smooth, or may present fatty, chalky, or albuminous changes like those seen in diseased arteries. In very large or old cysts the walls sometimes suppurate. By the pressure exercised by the cyst, the gland-tissue atrophies, or undergoes adipose transformation; and the effects of pressure upon the surrounding structures are very various. "The portal vein, inferior cava, and splenic vein; the pylorus, duodenum, colon, gall-bladder, and biliary passages; the stomach, liver, spleen, and right kidney; and, lastly, the solar plexus of nerves may be structurally involved or locally displaced, rendering diagnosis most difficult, and post-mortem examination most unsatisfactory." So writes Dr. Johnston, in an admirable article on Calculous Affections of the Pancreatic Ducts.[1]

The contents of the cysts may be either altered pancreatic secretion, or nearly pure mucus, or a serous fluid; cholesterine, broken-down cells, pus, blood, and crystals of hæmatine have been found in a large number of cases. In Bozeman's case, which will be again referred to, the fluid was of a light-brown color, specific gravity 1020, and of acid reaction, thus differing from the fluid of ordinary ovarian cysts, which is alkaline. Calculous concretions are sometimes formed in the cysts. Dr. Johnston has forcibly pointed out that not only do calculi, by occluding the pancreatic duct, cause the formation of retention-cysts, but that pancreatic cysts, however caused or formed, favor the occurrence of calculi. The capacity of the cysts varies from several drachms to ten or twenty ounces; in exceptional cases, very much more has been found. Bozeman speaks of two and a half gallons of fluid having been drawn off, in the case of his patient, and adds that the tumor, with the fluid, weighed twenty and a half pounds.

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[1] Amer. Journal of the Medical Sciences, Oct. 1883, p. 418.

Any part of the pancreas may be the seat of the cyst; and thus the tumor may occupy either the right or the left hypochondrium, or the epigastrium, or may be below the right lobe of the liver, or between the stomach and spleen, or in front of the spine. The cysts which spring from the middle part of the pancreas are the most likely to be early detected as abdominal tumors, on account of their being pushed forward by the bodies of the vertebræ.

Terminations.—The cyst may rupture into the stomach, duodenum, or colon, into the peritoneum, or behind the peritoneum. Extravasation of blood into the cyst is very likely to happen, and its occurrence is evinced by the chocolate-brown color of the cyst-contents, or by the bright redness of the fluid, if the hemorrhage has been quite recent. Sudden death is sometimes caused by intra-cystic hemorrhage. Atrophy, fatty degeneration, or inflammatory disorganization of the whole of the pancreas is prone to follow the development and growth of these cysts.

Symptoms.—The symptoms of pancreatic cysts are very various. Abdominal pain, gastric disturbance, emaciation, and the presence of an abdominal tumor, over the surface of which the tympanites of stomach, duodenum, or colon can be detected, are to be expected. When the cyst is due to distension, there may be jaundice, and fatty stools, with an inordinate appetite, or craving for food. Symptoms such as those last mentioned are brought about by the pressure of an impacted calculus against the common bile-duct, and by the complete obstruction to the flow of pancreatic secretion into the intestine. When the bile-duct, as well as the pancreatic duct, is thus completely obstructed by a pancreatic calculus, the evil consequences of the non-digestion of fat are still more marked. The occurrence of jaundice and fatty stools from the lodgment of a calculus in the duodenal end of the duct of Wirsung, should be borne in mind in considering the causes of biliary obstruction. Diabetes mellitus should also be looked for, especially when the cyst springs from the centre of the pancreas, since it is believed that atrophy and destruction of the cœliac plexus may give rise to the presence of sugar in the urine. Such cases do not, in my opinion, lend any color to the theory that diabetes mellitus is in any essential manner the result of morbid changes in the pancreas, but simply show that diabetes may follow if disease in the pancreas leads to secondary changes in the sympathetic ganglia and plexus.

A case recorded by Mr. Parsons,[1] shows the difficulty in ascertaining the exact cause of every case of pancreatic cyst, and furnishes an interesting example of the mode in which some of them progress and terminate:—

> A lady, aged sixty, the mother of ten children, had been for many years subject to occasional spasms of the stomach. At length she was seized by a very severe attack of spasm, followed by gastric inflammation, and ending in chronic gastritis. Four months after this acute attack, a tumor was discovered in the epigastrium, the size of a small orange, slightly movable, situated immediately in front of the spine, and behind the stomach. For a fortnight the tumor slowly increased, and then suddenly disappeared one night, with the passage of frequent stools of a glairy consistence, dirty-white color, and an odor like saliva. Temporary relief was followed by a return of the tumor, and by symptoms of renal irritation, with much pain and tenderness in the left lumbar and iliac regions; and after a few weeks a second tumor appeared immediately above the anterior superior spinous process of the ilium, and was plainly continuous with the former tumor—increased tension of the one being produced by pressure on the other.
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> For many weeks no notable change occurred, but the last formed tumor slowly enlarged, and there were great suffering and increasing emaciation and debility.

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[1] Brit. Medical Journ., June 6, 1857, p. 475.

Nine months from the time of the acute illness with which the disease began, the diarrhœa returned, with subsidence of the swelling and relief of the pain. This lasted two days, and then the tumor filled somewhat suddenly again. In ten days, the diarrhœa returned with copious vomiting, much dark, grumous blood being ejected both from the stomach and bowels. The tumors became flaccid and non-fluctuating, though still perceptible. The patient became extremely emaciated, and within less than ten months from the original seizure, died quite suddenly, with all the symptoms of internal hemorrhage. At the post-mortem examination there was found to be no peritonitis. The smaller curvature of the stomach, and what remained of the pancreas, were bound down tightly by adhesions to the spine, and these firm adhesions extended by the spleen and left kidney to the left iliac fossa. By these adhesions, a canal was formed, in which was the diseased pancreas, consisting, apparently, of a long cystic tube, extending from the duodenum to the left hypochondrium, and fully six inches in length. Behind the descending colon it became a cavity, the size of the fist, containing throughout a dark grumous fluid, like decomposed blood. The walls of the cyst were of cartilaginous hardness. There was, also, recent blood extravasated within the cyst. The tumor was adherent to the colon, and this part of the gut was soft and disorganized, but not ulcerated. The left kidney was softened and disorganized, but contained no calculus. The spleen was small, soft, and black. The left pleura contained much serum; the left lung was collapsed. The other organs were healthy, but wasted.

Treatment.—In the earlier stages the diagnosis must be uncertain, and nothing except the relief of prominent and distressing symptoms will be possible. For the amelioration of gastric irritability, sickness, and pain, freshly made whey, holding small quantities of soda in solution, has been found useful in counteracting the acrid gastric secretions to which the patients seem liable. In certain cases when the tumor is evident, an exploratory incision should be made, and the cyst either emptied by an aspirating trocar and its walls stitched to the parietes, or the cyst itself extirpated bodily. Kulenkampff, of Bremen, has recently evacuated a litre of fluid from a pancreatic cyst, the walls of which he had previously united to the parietal peritoneum. A drain was kept in for a time, and a temporary fistulous opening resulted; but it ultimately closed within a few weeks. Thiersch has treated a cyst of spontaneous origin in the same way, letting out three litres of chocolate-colored fluid; but in his case a fistula remained.

Pancreatic cysts have within quite recent years been removed by operation. Rokitansky, of Vienna, and Bozeman, of New York, have each performed the operation, but each under the impression that the tumor was ovarian. Rokitansky was not able to complete the extirpation, in his case, on account of adhesions to the omentum, stomach, and transverse colon. The patient nearly died on the table, but rallied and lived until the tenth day. Bozeman's patient was forty-one years old, and the disease had been observed five years before the operation. The pedicle of the cyst was three-quarters of an inch long, and was attached to the tail of the pancreas; it was ligatured before the cyst was cut away. The patient completely recovered.[1] [Another successful case, with persisting fistula, however, is attributed to Gussenbauer,[2] and a fatal case, in which intestinal obstruction was caused by an abscess of the pancreas, to Rosenbach.[3]]

CYSTS OF THE MESENTERY, OMENTUM, AND PERITONEUM.—Simple cysts of the mesentery are occasionally met with, but they are rare. In their early stages they are difficult to diagnose, and in their later stages they are likely to be mistaken for ovarian cysts. This is the case with all or at least most intra-abdominal cysts of simple or serous character, as well as with others of less simple nature. Rokitansky says of the serous cysts of the peritoneum —regarding them as inflammatory products—"a pseudo-membrane includes, during its organization, a portion of the fluid exudation, and receives an internal serous investment. Such bladders are either connected with the peritoneum by means of a neck or stalk, or adhere to it by a broad base."[1] Knowsley Thornton has removed a cysto-sarcoma weighing twenty-five pounds from the mesentery; and in another case a multilocular cystic tumor which was situated in the omentum. Thornton believes that these cysts originate in the sub-endothelial layer of the peritoneum, and he refers to a case in which "the whole cellular tissue of broad ligament, pelvis, peritoneum, etc., seemed to have undergone cystic degeneration, the cysts all containing solid papillomatous growths."[2] Habershon describes a case of "fibrous cyst which could in great measure be separated from the peritoneum, and contained many pints of slightly milky serum;" it reached from the right iliac region as high as the liver, and closely resembled ovarian dropsy; it is described as a "spurious cyst in the peritoneum," and was considered to have been of inflammatory origin—a view supported by the fact that another cyst was found between the colon and the stomach, and that the intestines were matted together.[3]

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[1] Am. Journ. Med. Sciences, April, 1882, p. 572.

[2] Med. News, April 28, 1883.

[3] Gaz. Méd. de Strasbourg; and Med. News, Sept. 30, 1882, and Feb. 3, 1883.

Dr. Buckner[4] relates a case of simple cyst of the mesentery which he mistook for an ovarian tumor. He completely removed it from between the layers of the peritoneum forming the mesentery, and divided and ligatured the superior and middle mesenteric arteries in doing so. The patient recovered.

Mr. Lawson Tait[5] met with a very similar cyst, which he mistook for a parovarian cyst and exposed by laparotomy. After tapping the cyst he stitched its edges to the edges of the external wound, and introduced a drainage tube. The patient recovered.

A case of cystic tumor of the mesentery, which caused death by intestinal obstruction and peritonitis, occurred at St. George's Hospital.[6] The tumor was filled with a semi-solid, milky-white matter like putty, and a milky fluid; it hung down into the right side of the pelvis, and no less than four coils of intestine were found wound around it; the lower end of the small bowel was twisted cork-screw fashion around a stem formed by the mesentery. The pultaceous cyst-contents consisted of fat with much granular matter. The cyst itself was of a fibrous structure. The mesenteric glands—some of which were in contact with the cyst—were quite healthy. The ovaries were healthy. It occurred in a married woman aged twenty-three, who had been confined four months before, and who was suckling when attacked by the symptoms of peritonitis and obstructed bowel, which ended fatally in ten days.

Dr. Werth, of Kiel,[7] has reported a successful extirpation of a cyst of the mesentery, which was supposed to have originated in the mesenteric lymphatic glands. The woman had noticed the tumor three months before she sought advice; it was discovered during a sharp attack of colic, from which she often suffered, especially at meal times and after unusual exertion. She was reduced in strength and emaciated. The tumor lay above the pelvic inlet and was very movable; it was unconnected with the uterus and ovaries. Soon after an examination under chloroform, severe pain came on about the umbilicus, and the tumor, which had before lain close to the abdominal wall, sank into the pelvis and was covered by intestine. A tense cord could be felt on the left, near the middle line, running from the umbilical region to the pelvic inlet. Laparotomy was undertaken on account of excessive vomiting and failing strength. The intestines being pushed aside, this cord was found to run from the root of the mesentery to the tumor in the pelvic cavity. The tumor was within the mesentery, covered by a loop of intestine, and by a ring of mesentery like a ruff. Pappy fluid was exuded at two small round openings. The margins of the wound in the mesentery were brought together by catgut sutures. Some enlarged mesenteric glands, as well as the tumor, were enucleated. The patient recovered perfectly. The cyst-contents consisted of albuminous and fatty detritus without any formed elements; this Dr. Werth takes to have been inspissated chyle.

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[1] Manual of Path. Anatomy, Syd. Soc. Translation, vol. ii. p. 18.

[2] Trans. Path. Soc. Lond., vol. xxix. p. 150.

[3] Pathological and Practical Observations on Diseases of the Abdomen, etc., p. 573.

[4] Am. Journ. Med. Sciences, Oct. 1852.

[5] Diseases of Ovaries, 4th ed., p. 223.

[6] British Med. Journ., May 16, 1857, p. 405.

[7] Archiv. für Gynäkologie; Med. Times and Gazette, July 8, 1882, p. 52.

Rokitansky has described cysts of this kind. Probably Dr. Pitman's case, at St. George's Hospital, was one of chylous cyst. Klebs, Eppinger, Roth, and Péan, have recorded cases of cyst of the mesentery, but not of the same nature as Werth's and Pitman's.

CYSTS OF THE URACHUS.—Besides the permanently tubular condition of the vesical end of the urachus which has been many times observed, and to which attention has already been drawn under the name of urachal fistula, pouches or cyst-like dilatations of the urachus are sometimes found in the abdominal wall, or at the umbilicus. These cysts are results of the imperfection of the embryonic changes which should entirely obliterate the tube of the urachus. They are situated in the cellular tissue immediately outside the parietal peritoneum, and though often small, they may attain such a size as to simulate ovarian cystic disease. Their contents are serous, their growth is slow and painless, and they may be multiple; one instance at least has been reported in which there were three immense cystic dilatations. When situated at the umbilicus they may be mistaken for umbilical hernia; but the soft, elastic, and perhaps fluctuating feel—possibly the translucency—and certainly the history and irreducibility of the swelling, will assist to a right diagnosis.

Small cysts of the urachus are occasionally met with when dividing the abdominal wall; and Mr. Lawson Tait has related two cases of large extra-peritoneal cysts which he believes to have been urachal, and which in some respects closely resembled in their clinical characters ovarian or parovarian tumors.

In each of these cases a large cyst was situated between the transversalis fascia and the thickened peritoneum; in each case a large quantity of thick, brown, purulent fluid, mixed with large masses of fibrinous deposit, was contained within the cyst. In one case the cyst had been tapped, and ten pints of this fluid had been drawn off; subsequently thirty pints were withdrawn from it, and the cyst was removed in its entirety; the intestines and pelvic organs were non-adherent, and apparently healthy, and could be felt through the exposed but unopened peritoneal membrane. The inner surface of the cyst was composed of broken-down mucoid epithelium, infiltrated everywhere with pus, and lying upon a basement-membrane of muscular fibre. The tumor, though entirely extra-peritoneal, dipped into the pelvis on the right of the median line. In the second case the cyst was gangrenous. Both patients succumbed to the operation.

It is a remarkable thing, if the theory of the urachal origin of these cysts is correct, that the cysts remained so many years in abeyance, and then suddenly developed to such an enormous size.[1] The fatal results in these cases point out the risk there is in removing large extra-peritoneal tumors from the abdominal parietes. The vitality of the exposed and disturbed peritoneum is likely to be destroyed, and therefore incision and drainage would seem the better practice. Mr. Tait is of opinion that it would be best to remove a large portion of the denuded peritoneum, "and trust to a careful arrangement by sutures of the portions left."[1]

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[1] As bearing upon cases such as these, the reader is referred to a paper by Mr. Knowsley Thornton, in the twenty-ninth volume of the Pathological Society's Transactions (p. 145), on a case of "Peritoneal cysts, with blood-cyst of left ovary." Mr. Thornton believes the cysts in his case to have arisen in the sub-endothelial cellular tissue, and to have pushed the peritoneum and its contents aside. The cysts were removed, but the general peritoneal cavity was never opened at all—the ovary having been reached through two adherent layers of peritoneum.

DISTENSION OF THE GALL-BLADDER.

The gall-bladder may be distended by bile, thin mucoid fluid secreted by its own lining membrane, pus, gall-stones, or cancer, and several instances have been recorded in which, after death, the viscus has been found distended with air.

DISTENSION OF THE GALL-BLADDER WITH BILE is a common consequence of obstruction of the common bile-duct, but it occurs also independently of such obstruction. An old man, aged 87, died from concussion of the brain, cystitis, and pyelitis, eleven days after an injury to his head. The gall-bladder was completely stuffed with a mass of dry, mortary, inspissated gall, which was adherent to the thickened walls of the gall-bladder; there was no obstruction in the ducts. The commonest cause of obstruction is a biliary calculus; other occasional causes are a growth in some part of the duct, pressure upon the duct by a tumor in some neighboring organ, and obliteration of the duct at its intestinal extremity by an ulcer or cancer of the duodenum. Murchison[2] relates a case of enlargement of the gall-bladder with atrophy of the liver, caused by obstruction from a cicatrix after a duodenal ulcer. Dr. Vanderbyl[3] records one in which obstruction was due to cancer of the pancreas. Dr. Martin Oxley[4] has recently put on record a case of abdominal tumor, the size of a cocoanut, situated below the free margin of the liver, and caused by congenital atresia of the duodenal end of the common bile-duct. The child was five weeks old, much jaundiced and emaciated, and thirty-six ounces of bile flowed out on puncturing the tumor. A few days subsequently, this was tapped again, and sixteen ounces of bile were drawn off with Southey's tube and trocar. Four days after the second tapping the child died, and it was found that the tumor (which had existed from birth) was due to dilatation of the gall-duct, the gall-bladder being of normal size and empty; there was no opening from the common duct into the intestine.

The *symptoms* of distension of the gall-bladder from such causes as the above, are jaundice, absence of bile in the feces, presence of bile in the urine, and general fulness and tenderness of the liver. The tumor is pyriform in shape, and elastic, if not fluctuating, and it projects downwards from beneath the edge of the liver, in the normal situation of the gall-bladder. Its dimensions vary; the accumulation has been known to amount to twelve pounds[5] and upwards, the size of the sac being proportionally increased, so as to occupy a very considerable portion of the abdominal cavity. Dr. Bright[6] has recorded a case in which the gall-bladder, distended with bile, formed an oval tumor descending nearly to the crest of the ilium. M. Petit[7] mentions two cases of puncture of the distended gall-bladder which proved fatal; in one case two [French] pints of very green and viscid bile were discharged, and in the other about a chopine[8] of green bile. In Cline's case 20 ounces of bilious fluid were drawn off with a canula, and after death on the seventh day, the gall-bladder was found to extend down to the pelvis, and to contain two quarts of bile; the biliary ducts were also greatly distended, except where the common duct entered the duodenum, and here was a contraction through which bile could only be squeezed with difficulty. Mr. Todd, of Dublin,[1] opened an enlarged biliary duct in a girl aged 14, supposing it to be an hepatic abscess, and two quarts of viscid, green bile were evacuated through a canula.

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[1] Diseases of the Ovaries, 4th edition. 1883.

[2] Diseases of the Liver, Case LXI., p. 365.

[3] Trans. Path. Soc. Lond., vol. ix. p. 228.

[4] Lancet, December 8, 1883, p. 988.

[5] Dr. William Thomson, op. cit., p. 73.

[6] Op. cit., p. 271.

[7] Mém. de l'Acad. Roy. de Chir., tome i. p. 256.

[8] [Half a French pint, a little over 16 fluidounces.]

Some variety will also be found in the other symptoms; thus, if the dilatation be due to obstruction of long standing, the liver may at length contract to less than its natural size, in place of being full and enlarged. If the accumulation have arisen from impaction of gall-stones at the neck of the gall-bladder, or in the cystic duct, and these act like a valve, so as to allow the ingress of bile but not the egress, there may be no jaundice, no clay-colored motions, and no bile-pigmented urine. Such cases are, however, rare. The tumor may suddenly subside, owing to the dislodgment of the obstruction, in which event bile will be discharged freely with the feces, and the jaundice will soon disappear. If the subsidence of the tumor is the effect of rupture of the thinned or degenerated coats of the gall-bladder, fatal peritonitis will set in. In some cases the bile is gradually absorbed, though the obstruction remains, and then shrinking of the gall-bladder takes the place of distension. If, as sometimes happens, distension arises without any obstruction of the ducts, the gall-bladder may be emptied by pressure upon the tumor. In a case related by M. Petit, in which he was about to open a tumor in the hepatic region under the impression that it was an abscess, he had scarcely cut the skin when the tumor sensibly collapsed, and the patient shortly afterwards discharged a quantity of green bile. In another case of Petit's, the gall-bladder could be sometimes diminished by pressure, and sometimes underwent spontaneous evacuation. In a case in which I was asked to aspirate or otherwise open an abdominal tumor which was supposed to be, probably, hydatid, I declined to interfere, as I believed from the slightly icteric hue of the skin, the pale feces, and the high-colored urine, that the enlargement was more probably due to distension of the gall-bladder from a temporary cause. My colleague, at this suggestion, at once acquiesced in delaying puncture, and the diagnosis was confirmed in a very short time by the spontaneous disappearance of the tumor, the return of the stools and urine to their natural character, and the rapid general improvement in health. It is unwise to make any forcible attempt to reduce such a swelling by manipulation or pressure, for, as Bright pointed out, after long distension the walls of the gall-bladder become so thin that they may give way under ordinary handling. He refers to a case in which this actually occurred during post-mortem examination.

DISTENSION OF THE GALL-BLADDER WITH FLUID SECRETED BY THE MUCOUS GLANDS AND EPITHELIUM OF THE SAC.—This is what is known as "dropsy of the gall-bladder" (*Hydrops cystidis felleæ*), and as *Cholecystonchus*. The longer the obstruction has existed, the freer the fluid from admixture with bile; and if the distension is very extreme, its coats may be so thin that the gall-bladder, as Walther has remarked, is as pellucid as the bladder of fishes. The characters of the fluid vary, and it appears that the mucous secretion of the gall-bladder often deviates from the normal standard. It may be a thin and flaky, or a thick and starchy fluid, coagulable into a firm mass by heat, acids or alcohol, and, except that the coagulum seems denser, it very accurately resembles serum.[2] It is a sero-mucous fluid, either transparent or colorless, and is derived from a membrane in a state of chronic inflammation.

[1] Dub. Hosp. Rep., vol. i. page 325.

[2] W. Thomson, op. cit.

The tumor caused by the accumulation of this fluid is generally painless, but not always so; and it is sometimes tender to the touch. Though the patient suffers headache, sickness, and constipation, and grows thin, the tumor is unattended by febrile disturbance, and is thus distinguishable from an abscess. Its formation is commonly preceded by biliary colic, and this symptom, with the situation of the tumor, distinguishes it from the kind of enlargement for which it is most likely to be mistaken—namely, a hydatid cyst. When examined with the patient under chloroform, the gall-bladder, whether distended by bile or by this dropsical fluid, is often freely movable in a lateral direction, and, though its base is fixed, the fundus and apex can be sometimes pushed across to the left of the middle line. On percussion, a tympanitic note is elicited on the sides of and below the tumor. If the distension be caused by obstruction at the neck of the gall-bladder, or in the cystic duct, jaundice will not be present.

Distension of the Gall-bladder with Pus.—This subject having been entered into when considering Biliary Abscess, need not be further discussed here.

Distension of the Gall-bladder with Calculi.—The mode of formation of gall-stones is an unsettled question, but it is probable that they result from precipitation from the bile, either as the effect of a diminished amount of cholate of sodium in the bile, or as a concretion around any foreign body, such as inspissated mucus or blood-clot, in the same way that urinary calculi are formed.

Gall-stones are composed of cholesterine, bile pigment, and earthy matter. Some are formed of pure cholesterine, and are then translucent, crystalline bodies; but most gall-stones, especially if of any size, are composed of all three substances, and are of a yellowish, brownish, or black color. Often the centre of a gall-stone is black, as if of pure pigment, and from it lighter lines radiate; sometimes layers of crystalline cholesterine and pigment regularly alternate. When the gall-bladder is distended with or contains several stones, they are polygonal, with smooth facets from the attrition or pressure of one against another.

The tumor formed by an aggregation of gall-stones, is hard and nodulated, and resisting. On palpation it gives a peculiar, crackling sensation, and a sound which has been compared to that caused by rolling small pebbles about in the mouth. The tumor does not vary in size from time to time, except that it increases, which it does very slowly. It is usually movable, and, though not always, is sometimes the seat of much pain; but whether actually painful or not, uneasy sensations are generally experienced over the hepatic or renal region from time to time. Jaundice is a common symptom, and a history of biliary colic is generally given. In some instances attacks of colic attended with agonizing pain occur at regular intervals throughout the course of the case.[1] In some there is a sensation of a heavy weight rolling from side to side in the situation of the gall-bladder, on turning in bed.[2] Vomiting is often excited, and the tumor has been known to cause all the symptoms of stricture of the pylorus. Mental depression, hypochondriasis, and symptoms suggestive of disease even in distant organs and parts of the body, may be caused in nervous persons by accumulated gall-stones. If ulceration is set up by the calculi, local peritonitis with acute pain must be looked for. In other cases the inflammation leads to very great hypertrophy of the coats of the gall-bladder, which have been found to be even half an inch thick.

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[1] Daly's case, Trans. Clin. Soc., vol. x. p. 11.

[2] Murchison, op. cit., p. 500.

ENLARGEMENT OF THE GALL-BLADDER FROM CANCEROUS DEPOSIT IN ITS COATS.—Cancer attacks the gall-bladder primarily, and spreads from it to the liver and peritoneum; or it invades the gall-bladder secondarily to the liver, pancreas, or pylorus, or it may even be some other and more distant organ. In most cases in which the gall-bladder is affected with cancer, it will be found to contain calculi.

The *symptoms* are severe shooting pains, with great tenderness on manipulation of a hard, and probably nodulated, tumor in the region of the gall-bladder. The tumor is usually fixed, and its growth rapid; it is sometimes soft in the centre, or at some other part of its surface, and then an external fistulous opening may be expected. In other cases the fistulous communication is with the colon, duodenum, or stomach, and then blood, and perhaps a biliary concretion, may be ejected through the mouth or voided by the rectum. The general impairment of health, and the emaciation and prostration, are more marked and rapid than in any other form of enlargement of the gall-bladder. Soft cancer of the liver is very likely to be mistaken for distended gall-bladder.

As a result of any form of mechanical obstruction to the flow of bile into the bowel, the biliary tubuli, as well as the bile-ducts, may be dilated; this is more especially likely to occur when the obstacle is in the hepatic duct, and when the gall-bladder is, therefore, not a vent-space for the impacted fluid. The distension of the tubuli may be so extreme that a sensation of fluctuation is communicated to the fingers applied over the surface of the liver.[1]

Treatment of Distension of the Gall-bladder.—The diagnosis of the cause of the enlargement must be made, and the treatment directed accordingly. In cases of over-distension from bile, the medicinal and dietetic remedies in common use for temporary obstruction must be employed, and will generally be followed by relief. In cancer, secondary to cancer of some other organ, the relief of symptoms as they arise is all that can be hoped for; but if the disease is primarily of the gall-bladder, the extirpation of the sac by abdominal section should be attempted. In cases of distension with pus and calculi, and in those instances of accumulation of bile or mucus in which other remedies have failed, operative measures will be required.

Whilst it must be borne in mind, on the one hand, that in distension without obstruction, the tumor may, at any moment, spontaneously subside; and that where permanent obstruction does exist, the bile or mucus may become absorbed, and the liver more or less destroyed or atrophied—in which case, either no necessity would exist for, or no permanent good would result from, the evacuation by puncture or incision—still, on the other hand, there is danger in all cases in which the tumor is rapidly increasing, that its thin walls may give way towards the peritoneum; or in cases of suppuration that the constitution may be worn out by hectic; or in cases of distension by biliary concretions, that death may be caused by the irritation, gastric disturbance, and emaciation, to which they give rise. M. Petit considered, as have many others, that there ought to be adhesions between the sac and the parietal peritoneum before the gall-bladder could be successfully punctured, and suggested the following as indications of such adhesions having been formed: (1) The impossibility of making the tumor change its position; (2) Œdema and redness of the integuments over the tumor; (3) Frequent recurrence of local inflammation. It is, however, very difficult to be quite sure of these adhesions; and, fortunately, it is unnecessary to be so for the safe performance of either aspiratory puncture or cholecystotomy.

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[1] Dr. Wm. Thomson, op. cit., p. 73.

Dr. E. L. Dixon[1] relates a case in which the gall-bladder was tapped five times with great relief, and a total of eighty-seven and a half ounces of liquid were withdrawn by the aspirator. The patient was jaundiced, and the common bile-duct was obstructed with cancer; so that though life was prolonged and eased, it was not saved by the operation.

CHOLECYSTOTOMY.

Under this term it is not intended to include those procedures, of which several are on record, for dilating fistulous openings for the removal of biliary calculi which have been detected by a probe, or finger, passed along a fistulous track. As in similar cases of stone in the kidney, such measures differ entirely in their conditions from a planned operation where no fistula exists. Cholecystotomy, like some other abdominal operations, has been long thought of, rarely performed, and strongly condemned, but now at last seems likely to find a recognized place in abdominal surgery. [It was clearly described, and distinctly advised in suitable cases, by Sharp,[2] of Guy's Hospital, in the middle of the last century.] In Good's Study of Medicine,[3] we find it stated that "Formerly, when the gall-bladder was suspected to be completely gorged, its walls thickened from long-continued irritation, the concretions too large to be forced forward, and the pain permanent and severe, attempts were made to remove them by a section into the cyst. Bloch gives a singular case of this kind, in which not fewer than sixty-two distinct calculi were taken away with success. But, in general, the operation has not answered, or has been followed by a formation of other crops of concretions; so that Morgagni, and many later writers of eminence, have strongly reprobated the use of the knife, and it is rarely or never had recourse to in our own day." Again, Dr. Andree[4] had long before written, "Lithotomy has been advised for the removal of biliary calculi. This, however, has arisen from the uncandid representation of a very uncommon case, but one which has, I know, occurred, to wit, of an abscess forming between the calculus and the integuments of the abdomen;" and he continues, describing a case of fistulous track leading to a calculus which was thus removed. In a case of Petit's, in which the tumor was opened contrary to his advice, on the supposition that it was an hepatic abscess, a fistula formed, and a calculus was extracted. In October, 1859, Dr. Thudichum urged the advisability of removing gall-stones by incision. In October, 1875, Dr. Daly and Mr. Maunder[5] discussed the operation of cholecystotomy in reference to a case of gall-stone impacted in the gall-bladder, and had Maunder been able to feel the gall-bladder or the stone, he was prepared "after the manner of gastro-enterotomy to cut down on the gall-bladder and secure it to the side; then, after adhesion had taken place, open the bladder and remove the gall-stone." The operation, however, was not done; the patient died; and it was found that, besides the stone in the gall-bladder, a still larger one was impacted in the common bile-duct, that all the biliary tubes, both within and without the liver (except the cystic duct) were dilated, and that there were numerous small abscesses in the liver substance.

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[1] Practitioner, April, 1876.

[2] Critical Enquiry into the present state of Surgery, 2d edit., p. 223. London, 1750.

[3] Op. cit., edit. 1825, vol. i. p. 420; ibid., edit. 1840, vol. i. p. 349.

[4] Considerations on Bilious Diseases, etc., pp. 45 and 64. 1790.

[5] Trans. Clin. Soc., vol. x. p. 14.

In April, 1878, Dr. Marion Sims[1] deliberately planned and performed the operation in a case of dropsy of the gall-bladder, and removed about sixty stones as well as the fluid contents; the patient died eight days after the operation, and at the post-mortem examination there were found other sixteen stones in the gall-bladder; all the biliary ducts were sacculated, and the small biliary tubes within the liver were much enlarged. Since then the operation has been performed by Mr. Lawson Tait,[2] Mr. Meredith, of the Samaritan Hospital for Women, London, and other surgeons [including Kocher, Rosenbach (two cases), Savage, Bobbs, Ransohoff, Winiwater, Gardner, Eddowes, and Keen, who has operated twice, and, in conjunction with Dr. J. H. Musser, has published an interesting article on the subject].[3]

Mr. Tait informs me that he has now operated on ten[4] occasions; that all the patients have recovered, and that in every case, save one, the operation has been successful in its results. In these nine cases the cause of the distension was calculus, and the contents of the gall-bladder mucus, though in three cases suppuration was beginning. Mr. Meredith's case has not yet been published, but he has furnished me, very kindly, with the full notes of it. Three stones, weighing collectively 1 ounce 26 grains avoirdupois, were extracted. The patient died forty-eight hours after the operation, but Mr. Meredith believes that the result would have been very different had the patient not had unsound kidneys, with almost complete suppression of urine some hours after the operation. At the post-mortem examination the gall-bladder (which had been stitched up and returned into the abdomen at the time of the operation) contained nearly a half pint of thick bile, the cystic and common duct were quite unobstructed, and the duodenum contained a considerable quantity of bile. There was no trace of peritonitis, although several ounces of dark bile were found free amongst the coils of small intestine; the bile, Mr. Meredith believes, escaped during the operation from the sponges introduced around the exposed gall-bladder, owing to the violent retching efforts of the patient whilst under the anæsthetic. The condition of the sutured wound in the gall-bladder, he adds, negatives the idea of the bile having escaped therefrom after the operation.

There are two methods of performing cholecystotomy, namely: (1) by the plan suggested by Maunder, in which the steps of the operation are divided by an interval of time into two stages—stitching the gall-bladder to the parietes, and waiting until after adhesions have formed before opening the viscus. Maunder adopted this practice in enterotomy, and it is now pretty commonly followed in gastrostomy. (2) The other plan is that carried out by Marion Sims, and followed by Lawson Tait. It consists in opening the gall-bladder and stitching it to the parietes at one operation. An incision from three to four inches long is made either in the linea alba (Tait), or over the outer border of the right rectus muscle (Meredith), or over the prominence of the tumor parallel to the linea alba (Sims). All bleeding should be stopped before opening the peritoneum. When the gall-bladder is exposed, it should be emptied of its fluid contents by the aspirator, and afterwards incised at the point of puncture, so as to admit the finger freely into its interior. Great care must be taken to hold the cut edges of the gall-bladder well up into the external wound, so that nothing shall escape into the peritoneal cavity. With minute pieces of sponge, in holders, the interior of the gall-bladder should be well cleansed, and any movable or loose calculi should be removed with ring forceps, or other suitable instrument. The edges of the wound in the gall-bladder should then be stitched with the continuous suture (Tait), or with several interrupted sutures (Sims used eight catgut stitches), to the upper end of the wound in the abdominal walls, leaving the opening into the gall-bladder quite free. Finally, the rest of the abdominal wound should be closed in the usual way. Great care should be taken to pass the sutures through the whole thickness of the parietes, including the peritoneum. Some light dressing, such as absorbent cotton-wool, boracic charpie, or lint soaked in carbolized oil, should be applied over the wound, and the abdomen lightly bandaged.

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[1] Brit. Med. Journal, June 8, 1878.

[2] Med.-Chir. Trans., vol. lxiii.

[3] Am. Journ. Med. Sciences, Oct. 1884.

[4] [Since increased to thirteen.]

There are one or two other points requiring caution in the performance of this operation: (1) No part of the wall of the gall-bladder should be cut away. These walls are sometimes thick and vascular, and not attenuated, and Marion Sims found much delay and inconvenience from the hemorrhage which followed the removal of part of the organ. (2) If stones are impacted in the neck of the gall-bladder, or in its duct, or are encysted in the walls of the gall-bladder, much care must be exercised in any attempt to remove them, or the walls may be perforated, allowing bile to escape into the peritoneum. (3) If the calculus is adherent to the mucous membrane of the gall-bladder, the walls may easily be torn, unless extreme care and gentleness are exercised. It would be better to leave the calculi behind than to run the risk of killing the patient by lacerating the parietes of the gall-bladder. (4) In spite of the satisfactory condition of the wound of the gall-bladder, and the patency of the ducts, found on post-mortem examination in Mr. Meredith's case, I am inclined to the opinion that no attempt should ever be made to close up the incision in the gall-bladder so as to return the viscus to the abdomen. There is a possibility that bile may escape between the stitches into the peritoneal cavity; but granting that this risk is very remote, when due care is employed in adjusting the sutures, there is still another and more forcible objection. It is that the surgeon cannot be sure that a calculus is not impacted in some part of the common or cystic duct, beyond reach of his finger or forceps. It is well, therefore, to provide a fistulous opening through which accumulating bile, or calculi which are not detected or which cannot be removed at the time of the operation, may subsequently come away. (5) The operation ought not to be too long delayed. As in other cases in which the surgeon's aid is sought for, but which do not in the first instance come under his charge—such as intestinal obstruction, renal calculus, hydatid tumor, hæmaturia from vesical tumors, and the like—so in impacted gall-stones and distended gall-bladder, physicians would do well to advise an operation, even if sometimes it should have to be commenced in the way of an exploratory proceeding, before general dilatation of the biliary ducts within the liver has occurred, and before hepatic abscesses are likely to arise. It is no objection to cholecystotomy that it must sometimes fail to save life, even though performed successfully and recovered from readily. A gall-stone impacted in the hepactic duct, or in the common duct, may still keep up symptoms of jaundice and colic, and eventuate in death by ulceration or marasmus; but even in these cases there will be relief from the pain of distension.

The operation may be performed either with or without Listerian details; there is ample proof in Tait's results that they are not in the least necessary, though in the minds of many surgeons they will be regarded as affording increased security. Thus, Marion Sims concluded his remarks on his own case by saying:—

> The great lesson this case teaches is this: In dropsy of the gall-bladder, in hydatid tumors of the liver, in suspected abscess of the liver, and in gall-stones, we should not wait till the patient's strength is exhausted, or till the blood becomes bile-poisoned, producing hemorrhages, but we should make an early exploratory incision, ascertain the true nature of the disease, and then carry out the surgical treatment that the neces-

sities of the case may demand. If this should be done under antiseptic precautions, I am sure that much suffering will be relieved, and many valuable lives saved that would otherwise be lost.

By all means let antiseptics be used with all the Listerian precautions, if by so doing surgeons may be able more readily to induce the physicians to follow Sims's teaching.

Cholecystectomy.

In rare cases in which the condition of the coats of the gall-bladder makes it unsafe to leave the organ in the body, its removal should be undertaken. Langenbuch, of Berlin, on opening the abdomen found the gall-bladder hypertrophied and adherent to the neighboring tissues, and containing a large number of stones, some of them adherent to the walls and threatening perforation. The viscus was emptied by a Pravaz's syringe, the liver was raised, and the colon and small intestines were pushed down by a sponge, and then the gall-bladder was separated from the liver by a few touches of the knife. The cystic duct was thus laid free and was ligatured in two places with silk thread, and divided between the ligatures. Great care should be taken not to wound the liver in detaching the gall-bladder, and catgut ligatures should not be used for the cystic duct. Langenbuch's patient made a good recovery, though she had previously undergone nephrectomy for floating kidney. [A second case operated on by Langenbuch has also terminated successfully.] S. W. Gross has removed the gall-bladder for calculi, and on the same patient he performed nephrectomy for cancer. It is not wonderful that the patient died on the second day of peritonitis: with a malignant disease and the shock of a nephrectomy simultaneously performed, the cholecystectomy had hardly a fair chance.

Surgical Diseases of the Kidneys.

Renal Calculus.—There is but a step between the formation of gravel and of stone in the kidney. If the solid substances which are usually in a state of solution in the urine become excessive, so as to be deposited as crystals, and if these crystals are carried out of the system with the urine, we have the condition of gravel. If these crystalline forms are cemented together by a little mucus or blood-clot, and are afterwards added to by fresh depositions from the urine, we have a small calculus, which may either be passed off with the urine, causing more or less renal colic in its transit along the ureter, or may remain behind in one of the calyces, or in the pelvis of the kidney, there to grow by fresh accretion until it attains a size altogether in excess of anything which can pass along the ureter.

Calculi may originate in the uriniferous tubes, or in one of the calyces of the kidney; but when started into being in the tubes, the calculus grows into importance in a calyx, or in the pelvis of the kidney.

The most common form of renal calculus is the uric-acid, the next most common is the oxalate-of-lime. These substances, being but very sparingly soluble, are the most likely to be precipitated from the urine; but carbonate of lime, phosphate of lime, a mixture of phosphate of lime and the ammonio-magnesian phosphate—that is, the fusible calculus—cystine, xanthine, and finally urate of ammonium or the mixed urates, are found occasionally, though rarely, either as the nucleus or chief constituent of renal stones. Alternating calculi, of uric acid, oxalate of lime, and phosphates, in distinct layers, are not uncommon. It is said that in Egypt the eggs of the *Distoma hæmatobium* afford a nucleus for the formation of renal stones. Blood-calculi have been described, and a drop of dried blood is occasionally found as the nucleus of a mixed calculus. Dr. Scott Allison recorded a case of phthisis in which, after death, several black concretions varying in size from a coriander-seed to a horse-bean, and composed of blood of firm consistence, were found in the kidney. I have seen such concretions in the pelvis of a kidney in which a uric-acid and phosphatic calculus also existed.

Renal calculi are formed at all periods of life, from the latter weeks of intra-uterine existence up to quite old age. One or both kidneys may be affected at the same time, or one may become so subsequently to the other. One or many calculi may be formed in the same kidney, so that even scores have been found scattered through the organ. When the calculus is composed of oxalate of lime, it is generally single; when of uric acid it is often single, but it is far less likely to be so than when of oxalate of lime. In size and shape there is the greatest possible variety, from a small, round, smooth body, to a large, rough, and branched mass filling all the pelvis and calyces. Much depends upon the size of the stone, and also on its position in the kidney, as to the amount of damage wrought by its presence upon the renal structure. A stone as large as a marble, rough and sharply mammillated upon its surface, may remain confined to one of the calyces for years without giving rise to more change than induration of the whole organ, due to slight chronic interstitial inflammation. On the other hand, quite a minute stone, not much if any larger than a mustard-seed or grape-seed, whilst in the tubular structure of the kidney will excite congestion, and even acute inflammation and abscess. When a stone is of such large size that it fills the renal pelvis, or when, being much smaller, it falls like a ball-valve into the upper end of the ureter, it leads to chronic inflammation, to dilatation, and to those atrophic changes which accompany hydronephrosis and pyonephrosis; or nephritis, pyelo-nephritis, abscess in the perinephric tissues, or profuse suppuration within the kidney, may be the result.

Symptoms.—A small stone may develop, travel, and escape, without giving rise to any symptom. A stone of moderate or even of large size may exist for years without causing any noticeable symptoms; and, having been uncomplained of during life, may be met with as a surprise when the body is examined after death. As a rule, no doubt there is, at some time, blood or albumen mixed with the urine; some lumbar pain or aching, aggravated by exercise or by any jarring or jolting movement; some vesical irritability; perhaps some pain in the testicle of the same side. If the stone has existed a long while, pus, mucus, or albumen will be found daily in a minute, or moderate, or marked quantity in the urine; and if blood is not invariably present (and in many cases it is not), it sometimes occurs in large amount, making the water bright red, or porter-like in color, for several days together. If with these symptoms the patient from time to time passes gravel, or minute calculi, or fragments of calculous matter, the diagnosis becomes conclusive. Movements, such as those caused by carriage-exercise, running, or walking, are not in all cases needed to cause exacerbation of the lumbar pain: on merely turning in bed, or even when lying asleep, the patient may be aroused by a sudden agonizing seizure. It would thus seem that the varying pressure of the abdominal viscera, the passage of feces along the colon, the variations in the degree of intra-renal blood pressure, are all capable of exciting pain by making the, often, acicular surface of the calculus press against the renal tissue.

As soon as a stone enters the ureter, or is being propelled along it, stretching it as it goes—partly by the weight of the accumulating urine behind, partly by the vermicular contraction of the muscular coat of the ureter, aided too, perhaps, by the retching and vomiting which its transit excites—renal colic sets in. The attacks of renal colic come on suddenly, last for hours or days, and almost as suddenly subside; to recur at some future period if the stone, instead of escaping at the lower end of the ureter, is simply displaced from the upper orifice into some less important point in the renal pelvis. Recurring attacks of colic arise also from fresh formations of renal calculus. I had a gentleman under observation, some time ago, who had had three distinct and severe attacks of colic; each lasted about three days, and they came on at almost time-regulated intervals of six months. From thirty-six to forty-eight hours after each attack, a small, irregularly rounded, smooth-surfaced calculus was voided with the urine. He was placed upon a regulated diet, and ordered soda water, with bicarbonate of sodium added to it, as a daily drink; and he has had no attack since—now nearly two years. During these attacks the pain shoots down the course of the branches of the lumbar plexus, and is felt in the bladder, in the groin, along the thigh, or in the testicle. The testicle may be retracted at the time, and afterwards become enlarged, and may remain for a long while tender if not painful. Women have occasionally aborted, men have committed suicide, and both men and women have been thrown into convulsions during the fearful agony of renal colic. The attack is often ushered in with a rigor, and is generally accompanied by vomiting, retching, and profuse perspiration. Faintness and collapse are by no means rare. The bladder is irritable; and the urine, which is diminished in quantity during an attack, is blood-stained and loaded with urates, and is sometimes passed with a good deal of scalding in the urethra. It sometimes happens that the other kidney becomes excited to increased secretion during the attack, and then the urine will not be diminished in quantity, and will not be thick. When the patient is very thin and the stone large, it can sometimes be detected on palpation of the loin.

It is important to know, with a view to surgical treatment, whether one or both kidneys are the seat of stone. There is usually not much difficulty in this, unless of course a stone is lying dormant in one kidney whilst symptoms are excited by the stone in the other; but it is necessary to bear in mind that a stone in one kidney will sometimes excite sympathetic pain and irritation in the other. This transferred or sympathetic pain is of an aching character, and not of a spasmodic or colicky description, as far as I have seen.

Treatment.—The treatment of renal calculus may be considered under three heads: (1) Prophylactic; (2) Palliative; and (3) Surgical or curative.

(1) *Prophylaxis* consists in employing a moderate amount of well-selected food, so as to preserve the digestive and assimilative functions in good order. Animal diet is not harmful if taken in moderation; nor is abstinence from an animal diet any security against calculus, as is proved by the prevalence of this disorder amongst the very poor, who scarcely taste meat. Immoderate eating, and an excess of animal or nitrogenized food, unquestionably conduce to the formation of renal calculus, and each individual ought to ascertain for himself what is moderation in his particular case, according to his mode of living, amount of exercise, and peculiarities of system.

(2) If a tendency to gravel or calculus is evinced, the free use of alkaline drinks is recommended as a *palliative* measure; so also is the employment of saline aperients, such as sulphate of sodium and magnesium, acetate of potassium, citrate of potassium, carbonate of lithium, or carbonate of lime; and the tartrates of potassium and sodium are also recommended. These remedies have, however, only a temporary effect; and for the most part the symptoms and the formation of calculous matter return soon after the discontinuance of the

remedies. The waters of Vichy and Ems are prescribed by those who prefer the alkaline diluents; of Carlsbad, Pullna, and Friederichshall, by those who advise the saline aperients. In either case, these waters are most advantageous when taken at their natural springs; the change of air, of mode of living, and of scene, all doubtless contribute to the improvement experienced. The solvent and preventive treatment of renal calculi will be more fully considered in the article on urinary calculus. During an attack of renal colic the treatment consists in the use of anodynes in large and repeated doses—sufficient to keep the pain in check. By allaying spasm they also facilitate the escape of the stone; and for the same purpose the hot bath, hot opium or belladonna fomentations to the loin and abdomen, and chloroform and ether inhalations, are useful. Anodynes may be given as morphia injections, subcutaneously; or in the form of morphia, opium, or belladonna suppositories. Warm diluents and diuretic drinks are sometimes recommended with a view of urging or pressing on the calculus by the corresponding increased secretion of urine, and its accumulating weight behind the stone. The patient should be kept in a relaxed posture, with the shoulders and thighs raised, thereby to diminish as much as possible the pressure of the abdominal parietes and contents upon the kidney.

(3) The *surgical treatment* of renal calculus will be hereafter considered under the heads of Nephrotomy, Nephrolithotomy, and Nephrectomy.

Nephrotomy, for a renal calculus which has given rise to abscess or fistula in the loin, or to a swelling which can be clearly detected through the parietes, is as old as the teaching of Hippocrates; but nephrolithotomy, for cases in which the symptoms of stone are subjective, and evinced only by pain, renal colic, and changes in the urine, is quite a modern procedure; and though now proved to be successful, was, till 1880, all but universally condemned. Nephrectomy, though of some years older date than nephrolithotomy, is also quite a recent innovation in surgical practice.

TUBERCULOUS AND SCROFULOUS KIDNEY.—Two forms of tubercle (so called) of the kidney are met with, (1) disseminated tuberculosis, and (2) strumous pyelitis, or scrofulous pyelo-nephritis.

These diseases are more common in children and below the age of puberty than in adult life; but they may occur, and more especially the "scrofulous" form of the affection, at any age. Men are said to be more frequently affected than women. Both kidneys are rarely involved to an equal degree, and the "scrofulous" form often affects one kidney only.

(1) In *tuberculous disease*, minute miliary nodules are scattered through the kidney, which is affected as part of a general constitutional malady in which other, it may be several other, organs are involved as well. These miliary nodules begin as gray granulations around the terminal branches of the arterioles which lie between the pyramids of Ferrein. These granulations infiltrate the vascular and connective tissues, and flatten the uriniferous tubes between which they occur. They are seen on the surface as small white dots, and they extend along the pyramids of the medulla, having a great tendency to spread downwards along the submucous connective tissue to the ureter and bladder, and to involve also the vesiculæ seminales, prostate, and testes.

(2) In *scrofulous disease of the kidney*—called also *strumous pyelitis*, *scrofulous pyelo-nephritis*, and the *inflammatory form of tubercular disease of the kidney*—masses of cheesy infiltration commence in the substance of the renal papillæ, and extend deeply into the kidney as well as downwards to the submucous tissue in the renal pelvis. Whether these cheesy masses are due to retrograde changes in confluent groups of miliary tubercles, or are the result of degeneration of the products of ordinary inflammation, pathologists

are not agreed; some, indeed, think that both conditions may exist at once, but that under such circumstances the tubercular take precedence of and excite the inflammatory changes. However this may be, much the same results follow. The body of the kidney is enlarged, and becomes lobulated by the extension of cheesy infiltration into the cortical parts of the organ; and, on section, conical masses of this cheesy material in different stages of softening are found to correspond with the prominences of the lobules. The pelvis of the kidney, and its ureter, are contracted by the thickening of their mucous and submucous membranes; and at a later period the mucous membrane ulcerates, and the lumen of the tube is choked by the softened, caseous or putty-like substance which escapes into it. Thus, often, both the mucous membrane lining the pelvis and infundibulum, and the secreting and tubular substance of the kidney, are affected; and the organ is converted into a huge abscess-cavity, or into a series of large irregular abscess-cavities with softened, caseous or puriform *débris* for contents. These contents readily wash away and leave exposed, white, shaggy, ulcerated walls, in which there is scarcely any, if any, renal structure traceable. In some cases, where only one organ is involved, the kidney becomes a mere shrunken, putty-like mass, in which abundance of cholesterine or calcareous nodules are formed in the lobulated spaces. This affection often has a chronic course, and certainly has a much less tendency to spread along the ureter, or to affect simultaneously other organs, than has the disseminated tubercular disease. Strumous pyelitis attacks chiefly, that is, essentially, the calyces and pyramids; whereas tuberculosis begins in the cortex and tends to spread rapidly to the rest of the urinary and genito-urinary organs.

Symptoms.—Disseminated tuberculosis of the kidney produces no characteristic symptoms referable to the kidney. In the early stages of *strumous pyelitis* the constitutional symptoms are not marked, and the local symptoms are absent. As the disease advances there is pain in the loin, with tenderness on pressure in the lumbar region. The urine may not be altered in quantity or character; or it may be excessive in quantity, in the early stage, and albuminous, alkaline, or acid, sometimes bloody or containing pus, minute cheesy masses, and *débris* of renal tissue, in the later stages. When it contains albumen the urine is always thick, cloudy, or opaque, and not clear as in Bright's disease; moreover, it never contains casts of the renal tubes. Occasionally there is suppression of urine, more or less complete, and then uræmic symptoms usher in the fatal termination. Often a tumor can be felt, or there is a greatly increased area of renal dulness; and if the disease be on the left side, the spleen may be so much pushed forward as at first sight to give the impression that the tumor is an enlargement of that organ. I have seen this mistake committed more than once; and in one instance in which there were no marked urinary changes, and in which the patient had suffered from ague, and a small ague-cake existed, the displaced spleen completely masked the large scrofulous kidney from which the woman ultimately died.

Vesical irritation in some cases has been the most prominent, and a most distressing symptom. A man was under my care, who, for weeks before his death, passed water with much pain and spasm, on an average 160 times in 24 hours. At the post-mortem examination, there was found scrofulous disease of the kidneys and ureter, but the bladder was quite unaffected.

In the advanced stages, there are marked rigors and exhausting sweats, or hectic. The temperature may be such as is seen in ague or hectic, or there may be intermittent periods of high fever, lasting for two, three, or four consecutive days, and followed by as many days of slightly elevated but not pyrexial temperature. Unless a tumor exists, or the characteristic cheesy *débris* is found in the urine, it is difficult, if not impossible, by the symptoms alone, to distinguish scrofulous disease of the kidney from pyelitis or pyelo-nephritis from any other cause.

Treatment.—The treatment consists in alleviating pain and improving the general health. Anodyne applications to the loin and lumbar region, and anodynes guardedly administered internally, together with cod-liver oil, bark, cream, or "maltine," and good, bland, nutritious diet, must be employed. If the kidney has been converted into an abscess-cavity, or suppuration has been set up in the perinephric cellular tissue, nephrotomy should be performed, and the cavity well irrigated and drained. Nephrectomy in *tuberculous* disease, in which the affection of the kidney is but a local manifestation of a constitutional disorder, would be useless even if the other kidney were sound. When, however, the *scrofulous* disease is limited to one kidney, nephrectomy promises much as a means of prolonging life by freeing the individual from a fatal malady.

Syphilitic Kidney.—Syphilis is now admitted to be an unquestionable cause of renal disease, though our knowledge of the precise effects of syphilis on the kidney is not yet perfectly accurate. There are three forms in which the kidney becomes involved: (1) Chronic or subacute interstitial nephritis, followed by atrophy of the kidney; (2) the formation of gummata, which are found only in a late stage of syphilis; (3) amyloid degeneration. Either the simple interstitial, or the gummatous form of inflammation may lead to cicatricial scars or puckerings on the surface, or in the cortical substance of the kidney, and to the consequent destruction of the tubules within the affected areas. Probably the atrophy which often follows interstitial inflammation is produced by arterial obstruction, resulting from the thickening of the walls of the arterioles of the cortical substance with inflammatory exudation; in this way the lumen of the vessels may be quite occluded. In support of this view may be mentioned the fact that there are sometimes seen patches of white or reddish-white color and granular appearance, resembling infarcts, surrounded by zones of congested tissues. Though gummata in the kidney are admittedly rare, they are recorded by Lancereaux, Klebs, Moxon, Greenfield, and others. Morell Mackenzie also has recorded a case of gummata in the liver and right kidney, in which the renal capsules were adherent.[1]

Symptoms.—The symptoms are much the same as those of Bright's disease, but with the addition of a syphilitic history and the evidence of a syphilitic cachexia. Albuminuria of temporary or persistent duration, and in slight or well-marked degree; fatty or granular casts of the renal tubes; headache; loss of appetite and color; nausea; œdema of the conjunctiva, eyelids, and ankles; and a gradually increasing sallowness of the complexion, are the common symptoms. Death may occur suddenly from uræmic poisoning; and Dr. Coupland has pointed out[2] that a feature common to all cases of late hereditary syphilis, and indeed to most cases of advanced syphilis, is the occurrence of death from parenchymatous nephritis. He records two cases of hereditary syphilis in which this change in the kidney was well marked, and was quite independent of lardaceous disease. Dr. Coupland has also recorded a very rare case of infantile syphilis,[3] in which a female child died at the age of three months from the impairment of the heart's action, due to infiltration of its muscular tissue with syphilitic new growth; there were also gummata of large size in the liver, and the kidneys—which to the naked eye presented a normal appearance—showed, under the microscope, in their cortical parts, an interstitial infiltration of small, round cells, most abundant around the arteries, and especially around the Malpighian bodies; the renal epithelium was unchanged.

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[1] Trans. Path. Soc. Lond., vol. xxii. p. 33.

[2] Ibid., vol. xxxi. p. 380.

[3] Ibid., vol. xxvii. p. 303.

Prognosis.—Though serious, the prognosis is not unfavorable as regards life, if proper treatment be employed in good time, unless, indeed, amyloid degeneration have taken place.

Treatment.—The treatment consists, as in other forms of visceral syphilis, in the internal administration of iodide of potassium, alone or combined with the solution of bichloride of mercury (liq. hydrarg. perchloridi); from five to ten grains of iodide of potassium, with one drachm of the solution of the bichloride [containing $\frac{1}{16}$ grain] in a little bitter infusion, or in an ounce of water, three times a day, is a favorite form of mixture for constitutional syphilis.

Amyloid Kidney.—Amyloid, waxy, or lardaceous degeneration of the kidney (*leucomatosis*) is one of the recognized forms of Bright's disease. It is a chronic affection caused by two classes of causes, viz., syphilis and suppuration. Of the various causes of suppuration, phthisis and caries of bone are the two most prevalent forerunners and producers of amyloid kidney. Amyloid degeneration of the kidney consists in a retrograde metamorphosis of the Malpighian bodies and small arteries, the glomeruli and arterioles becoming prominent and glistening; ultimately the basement membrane is affected, and transudation into the tubules takes place. Thus the appearances of the kidney differ in different stages of the degeneration. In the first stage, the organ looks almost natural in size and color, and in relation to its capsule as well as on section; but on the application of iodine or methylaniline, stained dots appear radiating from the base of the pyramids towards the capsule, and indicating the presence of degenerated glomeruli. In the second stage this degeneration is associated with secondary changes in the tubules, and the whole organ is enlarged, having a smooth, pale appearance on section, with cortical substance increased in thickness and of a dense consistence. Many of the tubules are blocked, and the application of iodine or methylaniline produces the characteristic reaction. In the third stage the kidney is atrophied, the cortical substance is relatively diminished, irregularly pitted on the surface, and of a yellowish-white, granular or striated appearance. On applying iodine, there is but slight change in the cortex, but the apices of the papillæ give the reaction well marked—brown lines extending upwards along the pyramids. This arrangement of the pigmentation is due to staining of vessels and tubules, whilst the absence of staining in the cortex is due to the breaking down of the lardaceous deposit, and to the destruction of many of the tubules. In none of the stages of amyloid degeneration is the capsule adherent, but other diseases of the kidneys in which adherent capsules are found (as, for instance, syphilis) may be associated with the amyloid degeneration.

The conditions in which the kidneys may be found, as a result of this affection, are simple amyloid degeneration, enlargement from transudation, and atrophy; these are the three stages indicated above.

Symptoms.—The commencement of this disease is gradual, and not marked by renal or urinary symptoms. Indeed, it may advance to a considerable extent, and yet not be discovered unless specially sought for. When, however, a patient with syphilis, phthisis, caries, necrosis, or any other cause of long-standing suppuration, passes a large quantity of light, limpid urine of low specific gravity, amyloid disease of the kidney should be suspected. The quantity of albumen contained in the urine is at first small, but it increases with the disease until at length one-fifth, one-third, or one-half albumen is present. In the later stages, hyaline casts are found. The urea and other constituents are seldom interfered with. Though there is no dropsy or ascites, other organs, and especially the liver and spleen, share in this degeneration, and, as a rule, but not invariably, these organs are more advanced in the morbid changes than the kidney. The complexion of a person who is the subject of amyloid viscera becomes waxy or pasty, the strength is wasted, the flesh is lost, and the blood is impoverished, so that the white corpuscles are increased, as they are in cancer and other wasting disorders, while it becomes, too, more watery.

As a rule, the cause of the amyloid change is also the cause of death before the amyloid affection is itself sufficiently advanced to prove fatal; but in exceptional instances death occurs from anæmia, or uræmia, brought on by the amyloid degeneration of the kidney and other organs combined. On the other hand, if the cause of the amyloid changes is removed, as by amputation, excision of a joint, etc., it is remarkable how soon and to what a degree the morbid processes recede, and the organs return to something like their natural perfectness.

Besides the liver and spleen, the bloodvessels of the gastric and intestinal mucous membrane, and the lymph-glands, are frequently the seat of amyloid changes; and the serous membranes are prone to become inflamed.

Treatment.—The most important indication is to remove the cause of the degenerative changes. Hence, if syphilis exists, it should be treated; and if suppuration is going on, it should if possible be arrested. Thus caries and necrosis, joint-disease, and fistulous communications with deep-seated abscesses should be dealt with, and if possible cured. In not a few cases the albumen in the urine will disappear, and the enlarged solid abdominal viscera will shrink to a normal size, after the cause of suppuration is efficiently removed.

Tumors of the Kidney.—The kidney is liable to many morbid new growths of a cystic and solid character, both benign and malignant. Several of these, however, do not attain to any size, nor cause the kidney to become appreciably if at all enlarged. Thus, *adenoma*, which occurs in two forms in the kidney—the papillary and the alveolar—is usually the size of a hazel-nut, or walnut, but seldom, if ever, as large as an egg or small orange; *angeiomata cavernosa*, though distinct formations or new growths of reticulated cavernous tissue, are of quite small size, not exceeding that of a marble, and though called tumors, the parts which they affect are often shrunken, rather than projecting or enlarged; *leukæmic tumors* are small, scattered, roundish patches of lymphoid cells, following the course of the capillary vessels, and looking not unlike extravasated white blood-cells, though they are sometimes actively growing tumors of a truly malignant character; *lymphadenoma* is found in the kidney, associated with similar disease of the glands, liver, and intestine; *fibroma* occurs "in the form of small white knots of fibrous tissue, near the bases of the pyramids" (Moxon), but occasionally, in the kidney, there has been found a very large, simply fibrous tumor; *villous papilloma* occurs in the pelvis of the kidney, as it does in the urinary bladder, and in a case met with in the post-mortem room of the Middlesex Hospital there were villous growths in the kidney and bladder of the same person; *syphilitic gummata* occur occasionally, but do not attain such a bulk as to greatly increase the dimensions of the kidney; various sized and numerous *cysts*, as in granular kidney, are present, without adding to the size of the organ.

Though pathologically of the nature of "tumors," most of the above-mentioned new formations never, others only rarely, give rise to tumors clinically speaking.

Clinically, any enlargement of the kidney which can be detected by physical examination at the bedside, is spoken of as a tumor of the kidney. Some of these enlargements have been already considered, namely, the hydatid and other large cystic tumors, and the enlargement of the kidney caused by scrofulous disease. There remain, however, other renal tumors for description, namely, carcinoma, sarcoma, and rhabdomyoma—all of the nature of malignant new growths—and two which are not new growths at all, namely, hydronephrosis and pyonephrosis.

HYDRONEPHROSIS is a mechanical result of obstruction to the outflow of urine from the pelvis of the kidney; and in the most extreme cases the seat of obstruction is generally the ureter. It consists in dilatation of the pelvis and calyces of the kidney by urine, and in more or less atrophy of the renal substance, followed by expansion of the capsule, and of what remains of the cortical and medullary substance of the organ. The tension exerted by the accumulating urine stretches the calyces, and flattens and wastes the pyramids, to such an extent that the calyces are converted into huge spaces, or sacs, jutting off from the dilated pelvis, and separated from one another by slender septa formed by the wasted "columns of Bertini."

In some instances of hydronephrosis, the degree of distension is such that a tense, irregularly rounded tumor occupies the renal region of the abdomen, and expands upwards to the costal margins, downwards to the iliac crest, and inwards as far as, or beyond, the median line, whilst it also bulges backwards into the loin. In exceptional cases, the tumor attains such a size as to distend the whole abdomen, and to assume the appearance and physical characters of an ovarian cyst. Several mistakes in diagnosis have been made in such cases, and operations undertaken as ovariotomies have either had to be abandoned, or have ended in the removal of the affected kidney. In other cases, again, the tumor has an intermittent existence, being prominent at one time, and not to be detected at all, at others.[1]

Causes.—Anything which obstructs the flow of urine from the kidney may cause hydronephrosis, but the largest tumors are formed when the source of the obstruction produces its effect gradually, and the obstruction becomes complete by slow degrees. A calculus impacted in the ureter, a new growth in the bladder blocking the vesical orifice of the ureter, a cicatricial or congenital contraction of the ureter, valve-like folds of the mucous membrane of, and convolutions or twists of the ureter, and the pressure of any tumor, of a pregnant or retroverted uterus, or of a hydatid cyst, or in fact any cause of external pressure upon the ureter will give rise to it.

Stricture of the urethra, cancer of the uterus or bladder, and other causes which affect the flow from both kidneys, produce hydronephrosis and pyonephrosis, but do not often cause distension of either organ to a sufficient degree to form an abdominal or even a lumbar swelling. Cancer of the uterus and vagina is a very common and fatal cause of hydronephrosis and pyonephrosis, but the degree of distension is not often great. The fluid contained in hydronephrotic cysts is limpid, opalescent, and imperfect urine, of a yellow, or, it may be, of a light-brown or light-red-brown color. Uric acid, urates, and oxalate of lime may be found in it. Sometimes the fluid is turbid, and contains muco-pus; sometimes there is blood-clot of old or recent date, which gives a brown or red color to the fluid. But in many cases the fluid is odorless, gives no reaction with heat or nitric acid, or with cupric tests, has a low specific gravity, leaves scarcely any residue on evaporation, and gives no evidence of urea or uric acid: in fact, it is only water holding a large quantity of chloride of sodium in solution, and containing a few epithelium cells.[2]

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[1] Med.-Chir. Trans., vol. lix.

[2] Ibid., p. 253.

Symptoms.—When the dilatation is insufficient to give rise to a tumor, there are no symptoms of hydronephrosis; it is simply a silent complication or consequence of some other condition to which the attention of the physician or surgeon is not called by any signs. When a tumor is formed, however, it has to be dealt with as a disease in itself, especially when it threatens to damage neighboring organs by its pressure, or to destroy life by bursting into the peritoneum. The tumor is sometimes irregular or lobulated, and frequently fluctuates; if it intermits, its subsidence is followed by the discharge *per urethram* of a large quantity of urine of low specific gravity, or having pus, or mucus, or blood in it. By its size it may cause much pain, and may interfere considerably with the action of the colon, thus inducing constipation. If it arises from some innocent and painless cause, its development will be unattended by any constitutional or local disturbance; but if from some painful cause, such as a renal calculus, the attacks of colic and other symptoms incidental to the particular cause will occur before the tumor makes its appearance.

Diagnosis.—The diagnosis of hydronephrosis from pyonephrosis and perinephric abscess is often excessively difficult, and in some cases cannot be made. Perinephric abscess causes fulness in the loin, and tends to spread upwards and downwards, but does not usually present a circumscribed, more or less movable tumor, coming forward in the abdomen, and felt as the patient lies on his back to be passing beyond the median line in front. In perinephric abscess there is often œdema and redness of the skin of the loin; in hydronephrosis this is very rarely the case, and only when the tumor has reached a great size.

In hydronephrosis, redness and superficial fluctuation are sometimes felt at a spot on the side or towards the front of the belly; in perinephric abscess the matter may burst at or below Poupart's ligament, but is not likely to point higher up in front. Pyonephrosis is indistinguishable from hydronephrosis, except when there have been rigors, feverishness, or other indications of suppuration, which in many cases of pyonephrosis are wanting. Hydronephrosis may suppurate quietly and thus become transformed into pyonephrosis.

Hydatid cysts, serous cysts of the liver, spleen, or kidney, and ovarian cysts, are to be distinguished by the clinical history of the cases; and ovarian tumors, as a rule, can be excluded by the direction of the growth of the tumor, by the relation of the colon—which is behind an ovarian, but in front of a renal tumor—and by the negative results of a vaginal and rectal examination. In ovarian cysts, the diagnosis will generally be assisted by some history of catamenial pain or irregularity; in renal tumors, by some urinary interference or change, at some period or other shortly preceding the formation of the tumor. A caution is requisite respecting the relation of the colon; occasionally, and especially when the tumor grows to a great size, the colon gets behind the bulk of the renal tumor; as a rare occurrence, a portion of intestine has been found in front of an ovarian tumor.

The *prognosis* of hydronephrosis depends much upon the cause of distension, but chiefly upon whether one or both organs are involved. If only one kidney is affected, and the other does duty for both, life may be prolonged, provided that relief from the distension of the tumor is afforded. Otherwise, death will result from the effect of pressure on neighboring organs, from rupture into the peritoneum, or from suppression of urine, or uræmia. In most cases where the distension affects both kidneys, the cause of the hydronephrosis kills the patient.

Treatment.—Aspiration should be employed when there is any reasonable ground for believing that the cause of obstruction is temporary, and that re-accumulation is not likely to occur. Kneading the abdomen has been successful when the tumor has been the result of convolution and sacculation, here and there, of the ureter; it might also succeed when the cause of obstruction was a small calculus or a retroflected uterus; but it is a measure which must be resorted to with extreme care, for fear of rupturing a tense, and perhaps softened or thin-walled tumor. If the cause of obstruction seems permanent or progressive, nephrotomy and drainage should be employed, and then, if the obstruction is subsequently removed, the fistula may be allowed to close; and if the obstruction is permanent, the atrophied renal substance may cease to secrete, or may become destroyed by suppuration, and thus the fistula will be healed. If a permanent fistula results, nephrectomy should be performed if the patient cannot or will not bear the discomfort and inconvenience of the fistula. This inconvenience can be minimized, however, by a simple apparatus fitted to the loin to catch and contain the urine.

PYONEPHROSIS.—Pyonephrosis, or dilatation of the kidney with pus, or pus and urine, is like hydronephrosis a mechanical result of obstruction, but it is something more. In pyonephrosis there is pyelitis as well as dilatation of the pelvis and calyces: there is inflammation of the mucous membrane of these parts, superadded to the mechanical distension and its results. In advanced cases the inflammation and suppuration extend beyond the calyces, and go on to the breaking down of the medullary and cortical substance, until at length the whole kidney is a largely dilated sac of pus.

A suppurating hydronephrosis is a pyonephrosis, and therefore the same causes which produce the one may give rise to the other; but, as a rule, the obstruction which at once causes pyonephrosis is more rapidly complete, and is thus attended by more irritation to the kidney than that which causes hydronephrosis. The organ has not time to go on gradually dilating and gradually atrophying whilst the other kidney *pari passu* is taking on compensatory hypertrophy; but inflammation is at once or very shortly lighted up by the same cause which checks the outflow of the urine. In one form of the disease, the cause of the inflammation is necessarily the cause of the obstruction: in those cases of strumous pyelitis where the pelvic mucous membrane is most affected, the entrance of the ureter becomes blocked by the inflammatory swelling—possibly by the swelling about an ulcer there; dilatation of the pelvis and calyces follows, the whole of the kidney-tissue is compressed, the pyramids are at the same time the seat of the scrofulous inflammation, and gradually the kidney is transformed into a large cyst filled with pus, with ragged, tubercular, suppurating tissue lining it.

In suppurating hydronephrosis, the pus and urine may be found in very different proportions in different cases.

Diagnosis and Treatment.—When the constitutional symptoms of suppuration, or the symptoms of pyelo-nephritis, are followed by a renal tumor, the *diagnosis* is fairly easy; otherwise it is impossible to distinguish hydronephrosis from pyonephrosis. This uncertainty, however, is of little consequence, as the *treatment* is the same in either case, except that where the fluid is purulent, nephrotomy and drainage through the loin should be at once resorted to without temporizing with the trocar. Nephrotomy has many times been performed in pyonephrosis, with advantage, and in some instances with completely successful results. On introducing the finger or fingers into a hydronephrotic or pyonephrotic kidney, through the incision in the loin, a large, lobulated or pouched cavity will at once be detected. Such a cavity will not be found in a perinephric abscess. The cavity is often far too large to allow of the finger reaching the orifice of the ureter, so that even if a stone be impacted there, it may not be discovered till the cyst has discharged for some time and has shrunk.

Abscess in the kidney is not to be confounded with pyonephrosis; it occurs in one form of surgical kidney, in pyæmia, and in scrofulous disease of the organ; but it never causes much enlargement in the first two conditions, and not frequently in scrofulous disease, unless the whole kidney is affected.

SOLID TUMORS OF THE KIDNEY.—Carcinoma, sarcoma, and myo-sarcoma or rhabdomyoma, occasionally occur as primary new growths in the kidney. Carcinoma is much more frequently secondary than primary. Injury and the irritation of calculus have, in several recorded cases, been the cause of primary cancer. Secondary carcinoma has, in quite a considerable number of cases, been preceded by carcinoma testis; in other cases, it follows cancer of the liver, stomach, breast, or uterus, etc. As a primary disease, it affects one organ alone; as a secondary disease, usually both kidneys are involved. It occurs as a primary disease in children before the fourth or fifth year; and in adults in advanced life. As a result of stone or laceration, it has caused death at the age of twenty-five. Though rapidly causing death after it has once commenced, it may require a long time before it is excited into existence: thus twenty years have elapsed between a fall which gave rise to a renal calculus with a blood-clot for its nucleus, and death from primary cancer of the kidney in which the calculus was situated.

All forms of cancer have been met with in the kidney, but either the medullary or scirrhous are the most common, and medullary cancer is much more common than scirrhus. That which attains the greatest size is the medullary when it attacks children. Colloid of the kidney is met with, like tuberculosis and carcinoma, as part of a general infection of the system.

Cancer begins either in the fibrous stroma of the cortex, or in the epithelium of the renal tubes. Frequently, however, the proper tissue of the kidney is invaded by a cancer, which has had its primary seat in the lymphatic glands or other structure about the hilus, and the disease, putting on the form of the kidney after penetrating the hilus and expanding the capsule, is called a "renal" cancer. Moxon thinks this the commonest plan of attack in primary renal cancer, and as it may be long before the renal pelvis is penetrated, and as the proper renal tissue remains long intact, we have, he says, the reason of the frequent absence of diseased products in the urine. The whole organ in time becomes infiltrated, and when the disease begins within the capsule this process is very rapid; and cysts and bloody or purulent collections form in the organ as the disease advances. There is nearly always a tumor recognizable during life. The tissues around the kidney, too, become adherent to the organ, and sometimes the cancer advances outwards until it is immediately beneath the skin in the loin.

Symptoms.—The presence of a tumor in the loin, is almost a constant symptom in renal carcinoma. This tumor, though sometimes tender, is, as a rule, painless, until by its increased dimensions it exercises severe pressure upon surrounding structures. The pain radiates far and wide, and perhaps increases paroxysmally; œdema, constipation, and vomiting, and jaundice if the right kidney is the seat of disease, are frequently present. Hæmaturia is not seldom noticed before a tumor; in some cases it is slight, or altogether absent; in others it is severe. Sometimes clots of blood partially block the ureter for a time, and then, after all the coloring matter has been washed out of them, are passed *per urethram* as colorless, fibrinous shreds or columns. As a rule, the urine offers no indication of the nature of the tumor; but occasionally, not only blood or coagula, but small cancerous masses are voided.

The *diagnosis* has to be made, first as to the seat of the tumor, secondly as to its precise nature. The exact locality of the tumor when first seen, its direction of increase, and the line of surrounding dulness or resonance on percussion, will help to fix the renal origin of the swelling, as distinct from an origin in the liver, spleen, or ovary. But errors in this respect are sometimes unavoidable, and I have found, on post-mortem examination, a large cancer in the kidney of a man who had been supposed by some most capable diagnosticians to be the subject of a liver-growth. Similar errors as to the spleen, when the left kidney has been the seat of cancer, are on record. The rapidity of growth of the tumor, its unequal resistance and nodular outline, and the progressively cachectic aspect of the patient, point to cancer; and when a swelling, which has begun on one side of the abdomen and in the renal region of a person either below the age of five or over that of sixty years, rapidly attains a very large size, its cancerous nature may be diagnosed with fair certainty. Whether in children or adults, it is a common thing for these tumors to reach a weight of eight or nine pounds, and upwards.

From enlarged mesenteric glands, renal cancer is distinguished by its one-sided position and less nodular outline; from cancer of the colon or small intestine, by the absence of characteristic intestinal symptoms.

The aspirating needle will furnish negative evidence, and will show that the tumor is due to one of the forms of solid growth, as distinct from cystic. It can do no more. The progress of cancer of the kidney is very rapid; from eight or nine months, to one or two years, according to the situation in which the growth has originated, is the usual duration of life after the commencement of the disease.

Treatment.—This can only be palliative in the middle and later periods of the disease. In the very early stage, could the growth be recognized then, nephrectomy would seem to offer a prospect of postponing the fatal result, perhaps even of considerably prolonging life.

Sarcoma sometimes forms in the kidney, and attains a formidable size, though it is also met with of a size not larger than a walnut. In one specimen in the Middlesex Hospital Museum, such a growth occupies the renal pelvis, together with a large, branched calculus; but the kidney is not at all increased in dimensions. When of large size, renal sarcoma resembles carcinoma clinically.

Rhabdomyoma.—Cases of renal tumor of probably congenital origin, and composed of striped muscle and sarcoma-tissue, have been recently recorded by German and English pathologists. These tumors have been removed after death from infants of from six to eighteen months old. In some instances there has been a tumor of each kidney; in some all vestige of normal kidney-structure has been destroyed; in others the tumor has lain beneath the renal capsule upon the surface of the kidney.[1]

Tumors of the supra-renal capsule occasionally occur, and though, as a rule, they are too small to give rise to abdominal swelling, they sometimes are of considerable size. They are not usually associated with any marked, still less with any characteristic, symptoms. Wilks and Moxon record a case of primary sarcoma of each supra-renal body. Each capsule was greatly enlarged, and of the size of a fœtal head of full term.

Primary cancer of these organs is very rare, but cancer of the supra-renal capsules, as part of a general cancerous infection, is by no means so. Averbeck has collected forty-three cases. Melanotic sarcomata, malignant blood cysts, hydatid cysts, and adenomata of these parts have also been found. Moxon speaks of growths of supra-renal tissue "forming considerable tumors, say of the size of a chestnut, in or upon the supra-renal capsules." These adenomatous new growths are single in each capsule, but both capsules may be similarly affected. Virchow, who looks upon the medullary part of the supra-renal capsules as allied to nerve-tissue, proposes to group its tumors amongst the gliomata.

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[1] For a full account of some of these tumors, the reader is referred to Trans. Path. Soc. Lond., vol. xxxiii. pp. 312, *et seq.*

SURGICAL KIDNEY.—Many morbid conditions of the kidney, the results of disease of the urethra, prostate, or bladder; or occurring in cases of paralysis necessitating the use of the catheter, or after surgical operations upon the urinary organs, are grouped together under this head.

Acute and chronic interstitial nephritis, uncomplicated with pyelitis or suppuration, and with or without dilatation of the kidney; suppurative nephritis and pyelo-nephritis; and the tough, shrunken, scar-marked kidney which follows recovery from simple, acute, and chronic inflammation, are all included by authors under the term "surgical kidney." For the anatomical characters of these several lesions, I must refer the reader to works on pathology.

Stricture, prostatic enlargement, vesical calculus, chronic cystitis from any cause, and various other diseases of the urinary organs, excite these lesions in the kidney, either by mechanically obstructing the urine, or by interfering with the renal circulation—either through the agency of the nerves or by changes in the intra-renal tension—or, again, by extension along the ureter to the kidney of putrefactive changes, which have commenced in the urethra or bladder.

As the disease known as surgical kidney has often appeared to commence after a surgical operation whereby the urethra or bladder is laid open, or after the introduction of a catheter, the admission of air, or of the agents of putrefaction contained in the air, is supposed to be an exciting cause. In some cases, the suppurative inflammation which occurs in the renal tract under these circumstances is regarded as being of an erysipelatous nature, and due to the direct introduction of the poison through the catheter or operation wound. This question has been fully discussed in an able paper by my friend, Dr. Goodhart.[1] Though in the majority of cases, the acute morbid processes in the kidney can be traced to extension of inflammatory disease from the bladder upwards, yet it is certain that in some instances of chronic disease in the lower urinary organs, the acute suppurative changes which supervene in the kidney begin in that organ, and, as far as they affect the ureter or bladder, do so only by extension downwards. These cases, too, are often most severe and even fatal. I have witnessed three or four such, and have followed them throughout their course to the post-mortem table.

Symptoms.—The symptoms vary with the character of the anatomical lesions. In simple, chronic, interstitial nephritis, even when associated with extreme sacculation of the kidney, there may be no symptom referable to that organ, except the low specific gravity of the urine, and, possibly, a lumbar swelling detected on palpation. (See section on Hydronephrosis.)

In the acute or subacute forms of the disease, especially when suppuration occurs, the symptoms are more or less pronounced. They begin with a rigor, or come on insidiously with slight chills, while the temperature will rise at night to 101° or 103° F., and fall in the morning, though not quite to the natural standard. The patient becomes dyspeptic, flatulent, weak, and emaciated, with a hot and often perspiring skin, offensive breath, loaded tongue, loss of appetite, and constipated bowels. The urine is passed in normal and often in excessive quantity, and contains mucus and pus in varying amount, with hyaline, granular, or pus casts. When acute nephritis passes into the suppurative condition, the urine becomes very offensive; pus, and often blood in small amount, are mixed with it, and renal epithelium and pus casts are sometimes found in large quantity.

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[1] Guy's Hosp. Reports, 3d series, vol. xix.

When "surgical kidney" results from some obstructive condition of long standing, and comes on in persons of, or beyond, middle age, there is very generally a deficiency in the elimination of urea, so that the urine, besides the other changes noticed, is of low specific gravity. As the disease advances, the skin becomes sallow or muddy-looking, the memory and intelligence show signs of waning, the patient, though drowsy, is restless, and as the end approaches he passes into a comatose condition, but without the convulsive seizures and other marked symptoms of typical uræmic poisoning.

In some cases of surgical kidney—as, for example, when acute suppurative nephritis occurs in a kidney, the subject of hydronephrosis and chronic interstitial nephritis—the attacks of pyrexia assume an intermittent character, last a few days, and then pass off for a few days or a week; and each attack corresponds with, and indeed is a sign of the subjection of a fresh area of the kidney to, inflammation and suppuration. During the attacks, the temperature will reach 102° to 103° F. at night, and 100° to 101° F. in the morning; the pulse is quick; the appetite is lost; the tongue is dry, coated, and foul; the bowels are constipated; the skin is dry and pungent; and there is flatulent distension of the stomach and intestines. During the intervals between the pyrexial attacks, the general condition improves, and the patient is less depressed mentally as well as physically. After five or six of these feverish periods—the interval between them shortening as they recur—the patient gradually passes into a state of low continued fever, and death, partially by coma, partially by asthenia, carries him off.

In other cases the symptoms assume a pyæmic or septicæmic nature.

The *prognosis* of surgical kidney depends upon its cause and upon the character of the induced renal disease. If the cause be removable or remediable, and if suppuration in the substance of the kidney have not commenced, recovery with a more or less damaged kidney may ensue. But if the cause of the disease is irremediable, as in cancer of the uterus or bladder, or if suppurative nephritis has commenced, a fatal termination must be looked for. When feverishness follows the use of the catheter, or any operative procedure, upon a person whose kidneys have been already damaged by chronic interstitial nephritis, alarm should be occasioned; and if the feverish symptoms continue, or intermit, an evil ending may be expected.

Treatment.—Prophylactic treatment is most essential. The cause of the obstruction to the outflow of urine should be removed if possible; and if this is not possible—and in many conditions, as, for example, in enlarged prostate, it is not—the employment of the catheter to prevent distension by retention of urine, and irrigation of the bladder to obviate the ill consequences of putrefactive changes in the urine and mucous secretion, should be had recourse to early. At the same time, care must be exercised against the risk of introducing any source of poison with the catheter; and to this end the instrument should be kept scrupulously clean, and before its introduction should be anointed with pure white vaseline, or with carbolized oil or glycerine (1 part in 16); and it should not be used by any one who is at the same time visiting infectious cases, except after carefully changing his clothes and disinfecting himself. By neglect of these precautions, there is reason to believe that poison has been conveyed from an erysipelatous or scarlet-fever patient, or from one with whitlow or some offensive wound, to another who, without organic disease of his urinary organs, has happened to require the use of the catheter at the hands of the same medical attendant that was attending the infectious patient. After the performance of any surgical operation upon the urinary organs, the patient ought to be placed in the best possible hygienic surroundings, and the same care should be used in keeping the wound clean, and in preventing putrefaction in and about it, as is exercised when the thorax or abdomen is opened, or a joint cut into or excised.

For the rest, the treatment consists in keeping the bowels open freely, and in assisting the digestive organs in the discharge of their functions. This is well done by a pill of three grains of extract of colocynth, half a grain of blue pill, and one and a half grains of Dover's powder, given every night; and by a diet consisting largely of milk, and milk and farinaceous puddings, a little fish, and good broth, beef-tea, or chicken-*purée*. Stimulants must be avoided, or given only in such quantity and in such form as will assist digestion. The action of the skin should be assisted and stimulated by warm clothing, by a regular and regulated temperature of the apartment occupied, which should be from 60° to 65° F., and, if necessary, by vapor baths, or by increased doses of Dover's powder.

Operations on the Kidneys.

In describing the operations performed upon the kidney for the relief or cure of what may now be called the "surgical" diseases of the kidney, I shall consider each under the following heads: What is the operation done for? How is it done? And what are its dangers?

The term "surgical diseases of the kidney" is used advisedly, because there are, and from their pathological character must always be, certain affections of those organs—such as the various forms of degeneration of the secreting structure, fatty, granular, cystic, and amyloid—which are not appropriate for any surgical treatment; and there are others, such as tubercle and cancer, which are but doubtfully fitted for it.

But the time has forever gone by when the words with which "dear old Lawrence" (to quote from a letter by a physician who had been his pupil) used to begin one of his lectures, namely, "the kidney, gentlemen, is fortunately beyond the reach of the surgeon," will find a single echo of assent.

Besides the use of the trocar or aspirator, there are four surgical operations which are now generally recognized, and which have been frequently performed upon the kidney; and the lives of many patients have been saved by them, whilst comfort and relief from great suffering have been afforded by them in many other instances.

The names given to these operations are sufficiently expressive of their objects and characters:—

1. *Nephrotomy* (νεφρός, kidney, τέμνω, I cut) is an incision into the kidney for purposes other than the extraction of a calculus, though it is quite possible that a calculus or calculous material may be removed after such an incision has been made. Thus on laying open an abscess of the kidney, one or more calculi may be detected lodged within the pelvis or calyces of the organ; or having ulcerated its way through the kidney, the stone may be found lying outside the suppurating organ.

2. *Nephrolithotomy* (νεφρός, kidney, λίθος, stone, τέμνω, I cut) is an incision into the secreting substance or pelvis of the kidney, with the express purpose of removing a calculus therefrom; and that too at a date in the progress of the disease prior to the disorganization of the renal substance, or the conversion of the renal pelvis into a large abscess-cavity. This operation is of quite

recent origin, and was, I believe, first performed by myself;[1] and when publishing the case in which I had employed it, I supposed that I had also for the first time proposed the name by which I had designated it. M. Hévin, however, in his exhaustive historical and critical researches upon nephrotomy, informs us that Schurigius,[2] in speaking of the proposal to perform the same operation, had called it la *néphrolithotomie.* But M. Hévin arrived at the conclusion that it was well nigh if not absolutely certain that cutting the kidney for stone had never been performd except in cases in which an abscess-tumor, or an external fistula, was present in the loin.[3]

The name however seems to have been quite lost, and the proposed operation had been "magisterially exploded"[4] by modern as well as ancient surgical authority, as may be seen by perusing the works of the writers whom I have quoted in the article above referred to.

Nephrectomy (νεφρός, kidney, ἐκτέμνω, I cut out) is the complete removal of a kidney, either through an opening in the loin or by abdominal section.

Nephrorraphy (νεφρός, kidney, ῥάπτω, I sew), consists in cutting down upon and exposing the kidney, and then stitching it to the edges of the wound in the parietes. It is undertaken with the object of fixing a floating or movable kidney.

PUNCTURING THE KIDNEY.—This may be done with a trocar or with an aspirator. It is performed for the relief or cure of hydronephrosis and pyonephrosis; large, isolated, serous or blood cysts of the substance of the kidney; and hydatid cysts. When from their degree of distension such swellings are causing serious consequences of pressure, or when there is risk of the cyst-wall rupturing, the contents ought to be evacuated.

The point selected for puncturing will depend on circumstances. If there be any spot over the swelling which is thin, soft, prominent, or fluctuating, the trocar should be there inserted. A point which is not seldom indicated is midway between the umbilicus and the anterior superior spine of the ilium, or half an inch below and an inch and a half to the side of the navel. When no particular spot is suggested by discoloration or prominence, no better place can be selected, on the left side, than an inch in front of the last intercostal space; but if the tumor be of the right side, this is too high, as the liver would be traversed. On the left side, the spleen, under ordinary circumstances, runs no risk of being punctured by inserting the needle well in front of the eleventh intercostal space, and if the spleen be projected forwards by the tumor, as I have sometimes seen it, it will be detected in its abnormal position by palpation, and must of course be avoided. "If there be no indication for operating elsewhere, I think the best spot to select, when the tumor is of the right kidney, is half way between the last rib and the crest of the ilium, between two and two and a half inches behind the anterior superior spine of the ilium. This spot is on a level with the front of the bodies of the lumbar vertebra, and a needle here passed horizontally inwards will be altogether in front of the kidney. It may, however, with safety be conjectured that, in any case of hydronephrosis of the right side *requiring to be tapped,* if the trocar be inserted at this place and directed somewhat forwards, the peritoneum and colon will be sufficiently in front to escape injury, the liver will be safely out of reach above, and the kidney behind, while the dilated pelvis of the kidney will be tapped at its anterior and lower part."

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[1] Trans. Clin. Society, vol. xiv. p. 30. London, 1881.

[2] Litholog. Hist.-Medic., cap. 13, par. i. 1720–32.

[3] Sur la néphrotomie, ou taille du rein. Mémoires de l'Académie Royale de Chirurgie, t. iii. p. 262. Paris, 1819.

[4] See Bernard's account of Marchetti's operation. Philosophical Transactions, vol. xix.

These remarks are taken from a paper on "Intermitting Hydronephrosis," published by myself in 1876, and are based on numerous experiments, some of which are there recorded.[1]

In performing the operation, the aspirating trocar should be inserted without any previous incision of the skin; if a larger trocar be used, an incision through the integument and muscles is sometimes made before introducing the instrument.

The dangers of the operation are very slight. If the puncture be made too far forwards, and through a non-adherent peritoneum, some of the contents of the cyst may be extravasated into the peritoneal cavity on withdrawing the canula—an accident which has proved fatal in more than one case. There is also the danger of wounding the intestine, which, as a rule, is in front of and adherent to the tumor, and if the trocar be long, or be thrust too far inwards, it may penetrate some important bloodvessels, and cause dangerous if not fatal hemorrhage. The penetration of the thin edge of the liver with an aspirating needle, though to be avoided, is not an accident likely to be followed by any ill consequence. The instrument should not penetrate too near the ribs, for fear of wounding the pleura.

NEPHROTOMY is performed for hydronephrosis when the cyst refills rapidly after having been punctured; for hydatid cysts under similar circumstances, or when from the number and size of the daughter-cysts the contents cannot be evacuated through a small tube; for pyonephrosis; and for any case in which the kidney has been converted into an abscess-sac, whether from the presence of calculus or tubercle.

The incision is precisely the same as for lumbar colotomy, except that, as the kidney is situated a little nearer the median line than the colon, the deep part of the wound should be kept a little posterior to that of colotomy. A slight oblique incision should be made in the costo-iliac interspace, beginning over the outer edge of the erector spinæ muscle, and continued forwards for three and a half inches. After dividing the skin, superficial fat, and fascia, the outer border of the latissimus dorsi, and the posterior border of the external oblique of the abdomen will be brought into view, and should be divided to the full extent of the superficial incision. It is unnecessary to open the sheath of the erector spinæ. Next, the internal oblique and the aponeurosis of the transversalis must be cut through, whereupon the outer border of the quadratus lumborum will be seen, and the deep layer of the lumbar aponeurosis must then be divided. No grooved director or other guide will have been necessary up to this stage, a scalpel and a pair of dissecting forceps for the operator, and two well-formed, deep retractors for his assistant, being all the instruments required beyond two or more pairs of torso-pressure forceps to control hemorrhage from any vessels cut in the division of the parietes. The peri-renal fatty tissue, having thus been reached, will, in all probability, be found condensed, and otherwise much altered, from the inflammatory process which has gone on in and around the kidney; and if the operation be done for abscess of the kidney, suppurative changes, perhaps, will have taken place in the structure forming the bed of the organ. When this tissue has been divided, the distended pelvis, cyst, or abscess (as the case may be) of the kidney should be either first tapped, or at once cut into, its contents evacuated, and the cavity well irrigated with some disinfecting solution. If it be thought desirable, as it is in hydronephrosis and cyst of the kidney, to stitch the cut edges of the cyst to the edges of the skin, this should now be done. A drainage-tube should be inserted, and the greater part of the wound left to granulate, though the anterior extremity may be brought together by one or more sutures with advantage.

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[1] Med.-Chir. Trans., vol. lix. p. 243. 1876.

The dangers of nephrotomy are not in the operation, but depend entirely upon the condition of kidney for which the opening is made. When done for cyst, hydatid or simple, the probability is that with a free drain for its contents, the cavity will soon contract, and the wound close by granulation; when done for hydronephrosis or pyonephrosis, set up by some permanent obstruction in the ureter, a continuous and persistent flow of urine, or pus mixed with urine, must ensue, and unless the fistula thus formed be removed by nephrectomy, a receptacle, into which the fluid can trickle and be retained, should be adjusted to the loin and constantly worn. Such an instrument has been made at my suggestion by Mr. Hawksley.

When nephrotomy is performed for abscess, recovery may take place; but if the kidney is completely converted into an abscess-sac, or is the seat of breaking down scrofulous deposit, the patient, though benefited for a time, may be worn out at length by suppuration or hectic.

NEPHROLITHOTOMY.—This operation should unhesitatingly be done in all cases in which symptoms of renal calculus continue uninfluenced by medicinal treatment, and are sufficiently severe to interfere materially with the comfort and usefulness of the patient's life. If for several months a person has been subject to more or less constant pain in one loin, and along the ureter, and, perhaps also, in the testicle of the same side; if there have been recurring attacks of renal colic, and especially if with these symptoms there has been occasional hæmaturia, or the urine has been constantly charged with a little pus or albumen, we have the conditions not only justifying, but demanding an exploration. If, in addition to these symptoms, a small calculus, or a little calculous matter has been passed *per urethram*, there is almost absolute certainty of the presence of a stone.

Symptoms strongly suggestive of renal calculus arise, however, from causes other than stone, and many times an exploration has been made of the kidney, and nothing found to explain the symptoms. But it by no means follows that no stone is in the kidney, because none is discovered upon examination; for subsequent events have in several instances divulged the existence of calculus in a kidney, in which a stone has been searched for in vain. Moreover, the exploratory incision sometimes greatly relieves the symptoms; this has been explained by Mr. Annandale, as probably due to division of some of the nerves in the lumbar parietes. From the temporary relief which followed one of my early operations, where the kidney was very loosely placed in its surrounding tissue, I was led to think that the contraction which followed cicatrization might have caused the improvement by fixing the kidney in its place, and I was quite prepared to act on this idea in a future case by plugging the wound, and thus making it heal by granulation. Another plan of treating mobile kidneys has, however, since then been practised by Hahn, of Berlin, and will presently be described under the heading of nephrorraphy. An unlooked-for advantage, in one instance, followed the exploratory incision in the following manner: nothing was found at the operation except considerable condensation of the peri-renal tissue; the wound healed rapidly, and the patient was much relieved, but some time afterwards the cicatrix spontaneously opened, and a quantity of pus escaped; the opening then closed for a time, and the cicatrix has since then several times alternately discharged pus and closed up, but the patient has been quite relieved from all inconvenience except the occasional purulent discharge. Here it would seem that the operation-wound prepared a way for the escape of matter from a peri-renal abscess, the antecedent inflammation of which had given rise to such severe symptoms as to lead to the exploration.

Operation.—An incision is made four and a half inches in length, parallel with, and three-fourths of an inch below, the last rib. The structures divided are the same as in nephrotomy. In nephrolithotomy, if the quadratus lumborum be so wide as to contract the deep part of the wound, its outer edge may be incised to the extent of one-half or three-fourths of an inch. All bleeding vessels having been twisted, and hemorrhage quite stayed, an assistant should stretch the edges of the wound widely apart with suitable retractors, and the operator, with two pairs of dissecting forceps, then tears through the peri-renal fat. As he approaches the back of the kidney, there will be sometimes noticed a difference in the character of this fat, that immediately in contact with the kidney being finer in texture and of a delicate primrose color. If from presence of the stone there has been inflammation in the tissues around the kidney, this appearance will not be expected, and the whole of the tissue will probably be dense and tough.

When the kidney has been fairly reached, the index finger should be passed carefully over the whole of the posterior surface of the organ, including its pelvis, and any inequality of surface, or increased hardness or resistance at any particular spot, should be searched for. During this tactile exploration—indeed, throughout the whole of the examination of the kidney—the abdominal walls of the patient should be well supported by an assistant, or by well arranged pillows, so that the kidney may not be pushed forwards by the exploring finger. If nothing suggestive of the presence of a stone is thus felt, the kidney should be freely exposed to view by drawing aside the edges of the wound, and a fine needle should be passed into the renal substance. This should be done in a systematic way, and in several places, if the stone be not at once struck—introducing the needle here and there, so as to puncture in succession the several calyces of the kidney, in one or other of which experience tells us that the stone usually rests. If in the course of the digital exploration some one spot gives more resistance than the rest, this should be first punctured, but otherwise the puncturing should be done in a well-planned manner. On this point I would lay great stress, as it is quite possible to puncture in a dozen places, and yet to miss the calculus.

If by this means the calculus is not detected, the search should not be given up until the fingers of the right hand are passed round the outer edge of the kidney, and the front surface felt over in the same way as the posterior. Whilst doing this, in order to give counter-resistance to the exploring finger, the kidney may be pressed against the psoas muscle, or be squeezed between the finger and thumb. Despite all these means, a calculus may escape detection. I recently removed by lumbar nephrectomy a healthy kidney for a calculus, the size of a marble, imbedded in it, but which I could not localize. The man recovered well, but the loss of so good a kidney was a very regrettable feature in the case. The kidney becomes very hard and tough under the prolonged irritation of a stone, so that, whilst the organ feels firmer than natural, any slight difference in the degree of resistance of one part is more difficult to appreciate. This hardness of the renal substance should make the surgeon very suspicious of a calculus, and future experience will, I think, encourage him, when this condition is present, not to be satisfied, either that no stone exists or that nephrectomy must be performed, until he has made such an incision into the kidney as will open each of the calyces. Kidney-wounds are known to heal readily, and whilst the risk of such an incision would not equal that of nephrectomy, the preservation of even a wounded kidney would be preferable to the sacrifice of the organ. The stone having been detected by one or other of the methods above described, the overlying part of the kidney should be cut into with a probe-ended, straight bistoury; then, with a scooping movement of the finger introduced through the incision, the stone, unless a branched or very large one, can be raised to the surface of the parietal wound on the point of the finger. Or a pair of forceps might be passed into the kidney by the side of the knife, and the stone seized and withdrawn. The finger is, however, much to be preferred, and if the incision is small, as it ought to be, the finger serves the purpose of plugging the renal wound, whilst it lacerates the renal tissue to the necessary extent. By this plan the hemorrhage is minimized, and the rent made with the finger heals as readily as the cut. When equally convenient to reach the stone, it is much best to open the secreting structure, and not the pelvis of the kidney; a wound in the former heals better than one in the latter, and the chance of a urinary fistula is therefore much less.

If the calculus be large and branched, it may possibly be requisite to break it up into two or more fragments, and remove the fragments separately. I have known this done in a suppurating kidney, but it is not probable that a stone will attain such a size as to require breaking before removal, without having in its growth more or less destroyed the kidney-structure. A stone, one ounce or less in weight, has been removed entire from a kidney which was not markedly enlarged, nor the seat of advanced suppuration.[1]

The after-treatment is very simple: a drainage-tube should be left in the back part of the wound, and the rest should be closed by sutures. For a time, of course, the whole or greater part of the urine secreted by the injured kidney will be discharged through the loin, but, after gradually diminishing, this may be expected to cease altogether in from three to four weeks. These lumbar wounds usually heal very quickly. In both nephrotomy and nephrolithotomy, some simple dressing, such as lint soaked in terebene and oil, or spread with boracic ointment, should be applied over the wound, and the drainage-tube should pass through this and be covered with a thick pad of absorbent cotton-wool, or Lister's gauze (I have used both, and with equally satisfactory results), retained in place by a light bandage. The dressings will require frequent changing, as they soon become saturated with the urine; to keep the bedding dry, a large pad of finely powdered German moss-peat should be placed beneath the loin, to receive and absorb the urine, as it readily does.

The dangers of nephrolithotomy are not great, as far as we can judge from present experience. The operation hitherto has, it appears, been uniformly successful, but the number of cases as yet recorded is but small. (1) Hemorrhage from the wounded kidney is not likely to be serious if the plan above suggested be followed. There may perhaps be a formidable-looking gush on first dividing the tissue, as in Mr. Marcus Beck's case, but compression with the finger or a sponge will soon check it. (2) Cellulitis may follow the operation, but with due precaution as to antiseptic cleanliness and drainage, this will almost certainly be escaped. It may, however, occur, and I am aware of one case in which extensive suppurative cellulitis followed an exploratory incision in search of a renal calculus; pus burrowed downwards to the pelvis, and upwards until the abscess burst into the lung, and though the patient ultimately recovered, he nearly lost his life. In this case there had been great liberty taken with the wound, and many hands had been introduced for the purpose of feeling the kidney. The kidney however was not cut into, and therefore nephrolithotomy cannot be properly charged with the complication, which was only such as might follow any deep wound in the loin, whether addressed to the colon, or kidney, or neither.

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[1] Bennet May, Trans. Clin. Society, vol. xvi. London, 1883.

(3) Renal abscess may possibly follow the operation as the result of wounding an organ already long irritated by the presence of a calculus. I do not know of it having occurred, and it is much more probable that any morbid change started by the calculus would be checked and repaired by the removal of the cause—a result which is proverbially known to occur in other tissues of the body. Moreover, if such a sequela should happen, it is only what would be sure to arise sooner or later if the calculus were to remain in the kidney. (4) A renal fistula, or a more superficial, purulent fistula, may follow, but though the chances are against its occurrence, such a result would be a welcome substitute for the ceaseless pain and chronic invalidism of the condition which it would replace.

NEPHRORRAPHY was first performed by Dr. E. Hahn,[1] of Berlin, though the experience of others, including my own, had quite prepared us to accept some such operation as a distinct step in the treatment of wandering kidney. It is practised in cases of floating, movable, or wandering kidney, in which the organ, besides being mobile, is the seat of frequent severe and spasmodic attacks of pain, or of more or less continuous suffering.

The operation consists in fixing the kidney in the loin, and is performed by exposing the organ through a lumbar incision such as that described for nephrotomy and nephrolithotomy. This done, a strong catgut suture should be passed through the renal capsule and the edge of the parietal wound. By tightening and knotting this suture, the kidney is fixed back against the lumbar parietes. The wound should be stuffed with carbolized gauze, or boracic lint, and left to heal by granulation. The operation has been performed several times by Küster, Esmarch, Bassini, David Newman,[2] and others, and with almost uniform success. In one case, however, Gilmore found that the suture cut its way out of the kidney and set the viscus once more free ; he afterwards successfully removed the kidney by lumbar nephrectomy. Dr. Robert F. Weir, in fixing the kidney of a woman aged thirty-three, cut along the outer edge of the quadratus lumborum, from the last rib to the iliac crest, thus making a longitudinal instead of an oblique incision, and stitched the peri-renal fat to the edge of the external wound, leaving this open to fill by granulation. The patient did well, and was greatly improved by the operation. Hahn also made a longitudinal incision, and in his first two cases simply stitched the peri-renal adipose tissue to the parietes by eight or ten catgut sutures ; but as the result in one of these cases was not quite satisfactory, he passed the catgut suture in his third case through the renal capsule. Hahn advises that the kidney should be fixed as low down as possible, so as to obviate the effects of dragging when the patient resumes the upright posture. Experience will have to decide whether there is any necessity for penetrating the envelope of the kidney. Gilmore's case shows that the same want of success may follow from the renal as from the peri-renal suture. Indeed, though a suture seems to give an extra chance of success, and adds but little extra risk to the lumbar incision, it is not yet adequately proved that any suture is requisite to attain the end in view. Before the publication of Dr. Hahn's paper, I had advocated the lumbar incision alone as a probable cure for movable kidney, and I had attributed the relief which followed in a case in which I had made an exploratory incision, to the retention of the organ in its place by the contraction and adhesion resulting from the wound. The surgeon must, however, look to the future to decide these and many other questions relating to the surgery of the kidney.

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[1] Centralblatt für Chirurgie, 23 Juli, 1881.

[2] Brit. Med. Journ., April 28, 1883.

Of course no operation should be undertaken for a floating kidney until pads and belt, and corsets, for steadying the kidney, and electricity, massage, and sea-baths, to increase the tone of the abdominal parietes, have been tried and failed; but fail in severe cases they almost certainly will do. The dangers of nephrorraphy are the same as those of nephrolithotomy, except that there is little or no hemorrhage from the kidney on introduction of the suture.

NEPHRECTOMY, or the removal of the kidney from the living body, was first performed as a planned operation in the human subject by Gustav Simon, of Heidelberg, in April, 1869. Blundell,[1] years ago, did nephrectomy on the rabbit, and proved that, in that animal at least, the kidney might be removed without causing death. Three different surgeons had preceded Simon in excising the human kidney, but without knowing the nature of the tumors they were removing until the operations had been completed. The first of these operations was performed in 1861, the others in 1867 and 1868. The ventral method was employed in each, and all the patients died. Simon's case was the fourth in which nephrectomy was performed, and the first in which the lumbar method was adopted. The patient fortunately recovered, and from that time the operation has been recognized as a legitimate one.

Lumbar nephrectomy should be performed in cases in which the removal of a disorganized kidney is advisable, after nephrotomy has been tried and failed to improve the condition of the patient; in cases of nephrolithiasis for which nephrolithotomy is not practicable; in cases of ureteral urinary fistulæ; in cases of wounded or ruptured kidney which are injured past the probability of functional repair, or in which blood-clots are being forced into the ureter, and plug it so as to lead to urinary extravasation into the loin, or to acute nephritis of the injured organ and threatened implication of the peritoneum. It should also be selected in dealing with renal cystic tumors, and small or medium-sized solid tumors of the kidney, and for some cases of painful, movable kidneys, which are condemned to removal. Other cases of large tumors, and of wandering kidneys very loosely held by a mesonephron, are better dealt with by the abdominal method. But here I would emphatically commend the teaching of Simon, who has laid it down as a cardinal principle that extirpation of a kidney is only permissible when a patient's life is seriously threatened by disease, and when all other remedies have failed, because renal disease is more dangerous in persons with only one kidney. The suffering caused by a floating kidney ought therefore to be quite irremediable by other means, before the patient is exposed to the great risks—operative and prospective—of nephrectomy; and in renal calculus no pains should be spared to procure relief by nephrolithotomy before proceeding to the much graver operation of excision. Rayer and Moseler have tabulated 14 fatal uni-renal cases; in 7 death was sudden, and due to obstructed ureter and anuria; and in 9 there was renal calculus.

It is probable that future experience will exclude from the category of cases for which nephrectomy by any method should be done, tubercular disease, and renal sarcoma in children, as well as cancer at any period of life. In cancerous tumors it is not likely that life can be much prolonged, unless in the exceptional cases in which the disease is detected before it has existed long, or has affected the lymphatic system. In tuberculosis, which, when it affects the genito-urinary tract, rarely confines itself to one organ, much temporary relief may be given by nephrotomy; but nephrectomy is only advisable, and safe from the special danger of anuria, in very exceptional instances. Here all will depend upon the character of the urine secreted by the other kidney—

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[1] Remarks on Abdominal Surgery. (Ashwell, op. cit. 1828.)

a point most difficult to determine. The best guides are: (1) The normal character of the urine as to absolute quantity and percentage of the excreted solids, the excretion of urea being the chief test. (2) The absence of albumen, over and above what is explained by the existence of pus in the urine. (3) The urine having an acid reaction. (4) The absence of vomiting—vomiting, as pointed out by Dr. Barlow, being often a distressing symptom when both kidneys are diseased. Mr. Davy informs me that the last application of his rectal lever has been to effect the compression of one ureter so as to ascertain the condition of the excretion from the opposite kidney. Methods of catheterizing the ureter have been proposed, but are not, I think, of any practical utility.

In speaking of tuberculosis of the kidney, a distinction ought to be made between it and strumous pyelitis or pyonephrosis. In the latter, there is less tendency for the disease to spread along the ureter, and to affect more than one part of the genito-urinary organs; and the disease chiefly affects the calyces of the kidney, whereas tubercle commences in the cortex and passes downwards.

The advantages of the lumbar operation are twofold: (1) the peritoneum is not opened, and (2) the wound permits of excellent drainage. It is performed most easily by the transverse or slightly oblique incision, as in nephrotomy, made somewhat nearer the last rib than in lumbar colotomy; with this should be conjoined a second incision, running longitudinally downwards from the first, and starting from it about one inch in front of its posterior extremity. In making the first incision, which should be about 4½ inches in length, the operator must not go nearer than half an inch of the twelfth rib, for fear of wounding the pleura, which sometimes descends a little below it. The second incision may be left until the kidney has been reached and explored, and it can then be made by cutting from within outwards with a probe-ended bistoury, steadied by the index finger of the left hand. One great advantage of the longitudinal incision is the increased facility which it affords for passing the ligatures around the pedicle. Other incisions have, however, been employed. Simon originally adopted the longitudinal; Klineberger made a curved incision, having its convexity upwards and outwards; and several surgeons have used the ordinary lumbar-colotomy incision alone. Lucas, in an excellent article on the surgical diseases of the kidney, recommends an oblique incision half an inch below and parallel with the last rib, and a second incision "along the outer edge of the quadratus lumborum, commencing at the upper edge of the last rib, and extending to the iliac crest;"[1] but the upper end of such an incision would be in dangerous proximity to the pleura, which would in some subjects be wounded by it.

The kidney being reached, the next step is to separate it from its surroundings. When no peri-renal inflammation has existed, the colon, peritoneum, and fatty tissue will easily be detached from their connection with the kidney, by the index finger of one hand worked close against the capsule of the organ. It will generally, however, I think, be found that, even when no inflammation has occurred, some of the renal capsule will be torn off and left behind; and in other cases, as when the operation is performed for calculous or scrofulous pyonephrosis, and as a subsequent proceeding to nephrotomy, the kidney should be enucleated from its thickened and adherent capsule, which should be left behind with the pedicle.

The next step is to pass a double ligature of plaited silk through the pedicle, between the ureter and the vessels. This is done by means of an aneurism-needle fixed in a long handle, whilst the kidney is dragged well up into the wound by the operator's left hand, one of the fingers of which can at the same time be acting as a guide for the needle. The needle passed and withdrawn, the ligature silk should be divided, and one-half of it should be tied tightly around the vessels, and the other half around the ureter. In doing this, the ligatures should be pressed well inwards towards the front of the spine, so as to leave plenty of room between them and the hilus for dividing the pedicle. The kidney should now be drawn quite out of the wound, a proceeding which is sometimes very difficult, but which will be greatly facilitated by dragging the lower ribs forcibly upwards with the fingers of the left hand dipped into the wound. Another ligature should be thrown round the whole of the pedicle, and securely and tightly tied before cutting the kidney free, which is now safely done by snipping through the ureter and vessels with a pair of blunt-ended scissors. Any bleeding points should at once be seized, and ligatured or twisted, and it is very probable that when the wound comes to be fairly looked into, as it can after the kidney is cut away, some moderate-sized vessel will be found bleeding. Some aberrant branch of the renal; or one of the inferior supra-renal arteries; or the branch to the upper end of the ureter, or to the connective tissue of the loin—all branches from the renal trunk; or one of the parietal branches of the aorta, may require control.

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[1] British Med. Journal, Sept. 29, 1883, p. 615.

All the ligatures should be cut off short, and the pedicle dropped into the wound. A drainage-tube should be fixed in the wound, the edges brought together with waxed-silk or fishing-gut sutures, and whatever form of dressing is commonly employed for fresh wounds by the operator, should be applied. The patient should be kept in the recumbent position until healing is complete, and the drainage should be kept up for four or five days. Healing is, as a rule, rapid, though the drainage-track will require from three to four weeks to close perfectly, and it is well that during all this time complete quietude should be observed, and great care given to the diet, so that the other kidney may not be irritated by too great concentration of the urine.

Some surgeons attach importance to the separate ligature of the artery, vein, and ureter; others, again, think it is unnecessary to ligature the ureter; and others, that the ureter had best be stitched to the external wound. The most important thing, however, is to securely control the vessels without putting too great a strain upon them in doing so. To attempt, in all cases, to get the kidney to the surface before ligaturing the vessels, would be to run a great risk of lacerating the coats of the artery or vein beyond the point at which it is possible to apply a ligature, and the advantage of leaving the ureter untied has yet to be proved. In no case is it advisable to excise the last rib; and where the costo-iliac space is very narrow, some other form of operation—not the lumbar—should be adopted.

The dangers of the lumbar operation are, that (1) the peritoneum or the colon may be torn open; (2) too great strain on the vessels of the pedicle may cause their laceration, or the ligatures may slip after the kidney has been cut off; (3) the kidney may be broken in the manipulations required for its separation and withdrawal. All these accidents have occurred, but they are not necessarily fatal. Laceration of the kidney requires the control of hemorrhage by pressure, and by hastening the completion of the removal: a great safeguard against hemorrhage from laceration is the application of the double ligature before attempting to withdraw the kidney. If the ligatures have slipped, or fail to control the vessels of the pedicle, or if troublesome hemorrhage from any source arises, it can be best managed by the application of one of Wells's large ovariotomy forceps, which should be left in the wound, and will, in addition, act very well instead of a drainage-tube. If the colon be torn, the rent should be closed by suture; if the peritoneum is opened, it may be either sutured or left without stitches, as the surfaces will fall together and quickly adhere. In Mr. Couper's case of scrofulous pyelitis, the hole in the peritoneum was sutured, but before this was done, pus from the kidney had contaminated the inner surface of the peritoneum; yet the patient rapidly recovered, and the operation, which lasted two and a half hours, was throughout all but bloodless.

Abdominal nephrectomy should be performed in cases unsuited to the lumbar method. These have been already specified. The best incision is that which many of the old surgeons employed in all abdominal sections, and which Langenbuch, of Berlin, has recommended and practised in at least two successful cases of nephrectomy,[1] namely, along the outer border of the rectus abdominis muscle on the side of the kidney to be removed. The middle point of the incision will probably correspond to the umbilicus, but this must entirely depend upon the size and outline of the tumor.

All bleeding, which is sometimes considerable in this incision, being stopped, and the peritoneal cavity opened, the state of the opposite kidney can be ascertained, if need be, by digital examination. The intestines should be kept aside, from off the surface of the kidney to be removed, by means of a large, flat sponge introduced into the abdomen. The outer layer of the meso-colon should next be opened sufficiently to allow of the introduction of two or three fingers, behind the peritoneum, and into the fat in front of the kidney; and the fingers should then gently teaze their way towards the renal vessels, around which ligatures should be secured. If the vessels are tied separately, care should be taken to tie the artery before the vein. The ureter should then be seized by two pairs of ovariotomy forceps, and divided between them. Langenbuch's object in selecting this incision was to divide the outer layer of the meso-colon, and so avoid the risk of hemorrhage; this is more particularly necessary on the right side, since the inner layer of the meso-colon covers the vessels passing to the ascending colon. The enucleation of the tumor should next be proceeded with; and lastly, the vessels should be divided outside the ligatures, and the mass removed from the body. The ureter should be tied with ligature silk like the vessels; or its upper end may be turned out (as I suggested at a meeting of the London Medical Society, in November, 1882) through an opening specially made in the loin, and then stitched to the external wound. Mr. Barwell has also advocated this mode of treating the ureter; but I am not aware that it has been carried into practice. The supposed advantage of bringing out the end of the ureter, is that it allows the escape of any pus or scrofulous material which it may contain, and that it permits the antiseptic irrigation of the canal. The advantage of this is doubtful, except, perhaps, in scrofulous pyonephrosis, whilst the plan of fixing the cut end of the ureter at the abdominal wound, seems to me to invite the future occurrence of intestinal obstruction.

Abdominal nephrectomy is completed like ovariotomy, and the subsequent treatment is the same. A median incision has been several times employed, but is not as good as that described above. The dangers of the operation will appear from the following comparison of the causes of death after the lumbar and abdominal methods.

From an examination of 42 fatal cases, out of 100 nephrectomies collected by Dr. Robert P. Harris,[2] I find that the following facts come out. The cases are arranged according to the nature of the operation:—

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[1] Transactions of the International Medical Congress. 1881.

[2] Amer. Jour. Med. Sciences, July, 1882.

Causes of Death.	Abdominal Nephrectomy.	Lumbar Nephrectomy.
Suppuration	1	0
Peritonitis	10 (4 being septic)	2
Hemorrhage	4	1
Uræmia	1	5
Shock	4	7
Infarction	2	0
Pyæmia	1	2
Vomiting	0	2
Total	23	19

As the whole number of abdominal operations was 46, and that of lumbar operations 50—the nature of the operation in 4 cases being uncertain—it appears that peritonitis, hemorrhage, pulmonary embolism, pyæmia, and exhaustion from suppuration, are more frequent causes of death after abdominal nephrectomy than after lumbar, in the proportion of nearly four to one; whilst the number of deaths from "uræmia," "vomiting," and "shock," after lumbar nephrectomy as compared with abdominal, is fourteen to five. The greater mortality of the lumbar operation from uræmia and shock, is due to the fact that in several of the lumbar cases both kidneys were diseased at the time of the operation, that in one case the last rib had been removed and the pleural cavity laid open, that in another the patient was reduced by cancer of the uterus, and that others of the patients were in an unfit state for any surgical operation of importance.

The abdominal operation, therefore, seems to be a much more formidable affair for the patient; and the fatality from causes directly traceable to the operation, and apart from the state of health of the patient, much higher. Looked at from the point of view of the totals, the same conclusion is arrived at, but the difference is not as striking. Thus, out of 100 cases, the nature and result of the operation were recorded in 96. Of the 96 patients, 46 submitted to abdominal nephrectomy, and, of these, 23 recovered and 23 died; 50 were operated on by lumbar nephrectomy, and of these, 27 recovered and 19 died. A good deal as to result depends upon the nature of the disease for which the operation is performed, but less than might *a priori* be expected. Of 18 operations for malignant disease, 9 were fatal; and of 16 for floating kidney, 6 were fatal. Of the 16 patients with floating kidney, 14 were submitted to abdominal operation, and 6 died; two were treated by the lumbar method and both recovered. Of 7 lumbar operations for ureteral fistula, 6 ended in recovery and 1 in death.

I think that the conclusion pointed out by these figures, is that, though in many cases, from the size of the tumors, the abdominal operation is easier, and therefore better, yet that the lumbar method is as a rule much safer, and should be preferred in all cases in which the kidney is not much enlarged, in which the tumor can be reduced by puncture, and in which the loin space is not too much contracted.

Kroner[1] has collected and analyzed 41 cases of nephrectomy. In 21 the abdominal operation was performed, with 14 deaths; and in 20 the lumbar operation, with 5 deaths, but in 3 others the result is unstated. From these cases Kroner concludes that the higher mortality of the abdominal operation is not owing to its greater danger, but that it is due to the fact that these cases include those in which the diagnosis was uncertain, and in which the operation was therefore commenced tentatively.[2] [The whole number of cases of nephrectomy hitherto recorded is over 150, of which at least 66 have terminated fatally—a percentage of mortality corresponding pretty closely with that derived from Kroner's and Harris's statistics.]

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[1] Archiv für Gynäkologie.

[2] Kroner's cases are included in Harris's list, but for a good abstract of Kroner's conclusions, the reader may refer to the Medical Times and Gazette for October 22, 1881.

Lateral Retro-peritoneal Nephrectomy.—Mr. Thornton has suggested a method which may be described as the lateral, retro-peritoneal operation. It consists in making an incision parallel with the linea semi-lunaris, but further out, and then reaching the kidney by raising the colon and peritoneum. The plan would probably answer very well for certain cases of tumor, and Mr. Thornton has employed it successfully in a case in which the ureter of a healthy kidney had been divided in ovariotomy. The advantage claimed for abdominal nephrectomy and for the lateral, retro-peritoneal method, is that they enable the vessels to be isolated and tied before the main enucleation is performed, and that thereby hemorrhage is saved.

The curved incision used for ligaturing the common iliac, or aorta, might be substituted for the lateral method of Thornton.

SPLENOTOMY AND SPLENECTOMY.

(*Excision and Extirpation of the Spleen.*)

In 1678, Matthias[1] removed the protruding spleen from a man aged 23, who had been stabbed. The patient recovered in three weeks. In 1711,[2] a woman aged 30 had an abdominal abscess opened to the left of the umbilicus, and a bluish body, which was seen at the opening, was removed; it proved to be the spleen. The patient made a good recovery, and afterwards bore a healthy child. Blundell,[3] in 1823, experimented upon rabbits, and in seven instances took out the spleen. Two recovered permanently, and were fat and well five years afterwards. Two recovered temporarily, but died three and a half and six months afterwards of peritonitis, and in each, a large sac about the size of an orange, and filled with a thin, puriform fluid, was found in the left hypochondrium. Three died from three to five days after the operation from peritonitis. Blundell also refers to two successful cases of excision of the spleen, in which the spleen protruded through a wound in the side. These cases have been referred to in speaking of wounds and protrusion of the spleen. (1. A case of sabre-wound received at the battle of Dettingen, and 2. A Mexican under the care of Dr. O'Brien.)

A surgeon named John Ferguson, of Strabane, writing in 1734[4] to Mr. Cheselden, Surgeon to Chelsea Hospital, describes a case of penetrating wound with protrusion of the spleen, three and a half ounces of which he ligatured and cut away after the wounded man had had his spleen protruding twenty-four hours; the patient recovered from the operation. In reference to this case, Ferguson, in his note to Cheselden, says, "for though you have taken the spleen out of a dog without any remarkable inconvenience, yet it has never been attempted that I know of in a human body." Other cases have been recorded,[5] which prove that complete recovery has taken place after total, as well as after partial removal of the spleen for injury with protrusion. Dr. Wilks[6] was the first in England, who by his writings advocated the trial of splenectomy for disease.

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[1] Quoted by Simon, of Rostock (Die Extirpation der Milz am Menschen. Giessen, 1857).

[2] Fantoni, Opuscula Medica. Genevæ, 1738; quoted by Simon.

[3] Ashwell, op. cit.

[4] Philosophical Transactions for October and November, 1738, p. 425.

[5] Cases are given by Hecker, Simon, and others.

[6] Guy's Hospital Reports, 3d series, vol. ii. p. 37.

Causes for which the Spleen has been Excised.—From a table published by Mr. Herbert Collier,[1] it is seen that out of twenty-nine operations performed for diseased conditions since the year 1549, thirteen have been for diseases other than leucocythæmia, and sixteen for leucocythæmia of the gland. Of these sixteen, all have been fatal. Of the diseases of the spleen unassociated with leucocythæmia, in which splenectomy has been performed, in two cases it has been floating or wandering spleen; in one, hypertrophy associated with a floating state of the organ; in three, hypertrophy from malaria; in three, simple hypertrophy; in one, hydatid followed by a sanious discharge; in one, secondary enlargement after cirrhosis, and associated with ascites and anasarca; in one, sequestrated spleen in peritoneal abscess; and in one, hypertrophy with a unilocular cyst containing three litres of viscid fluid. Of these thirteen cases, eight have recovered. [Of 43 cases of splenectomy for disease, to which the editor has references, 31 are known to have terminated fatally—a proportion almost identical with that shown by Mr. Collier's figures.]

For injury of the abdomen, implicating the spleen, and in several instances attended with protrusion, the results of excision and extirpation have been very encouraging. Nussbaum states that sixteen out of twenty-six operations performed for traumatic causes have been quite successful. [The editor has references to 21 cases of splenectomy for traumatic causes, all of which are said to have terminated successfully.]

Mode of performing the Operation.—The section of the abdominal wall has been variously made. In the first known case (Zaccarelli's, in 1549), the external incision was over the tumor. In Kuchler's (1855) and Spencer Wells's (1865) cases, it was along the outer edge of the left rectus. In Bryant's first case (1866), a longitudinal incision was made from the eighth rib to the anterior superior spine of the ilium on the left side; in his second case (1867), the incision in the left loin commenced "below the ribs, at a point corresponding to a line extending upwards from the anterior superior spine of the ilium, and curving downwards and forwards in front of the crest. This line of incision was selected as it was supposed to correspond with the horizontal line of the spine, and would thus, on the removal of the spleen, enable the surgeon to have the pedicle of the gland more immediately under his observation and control, and tend to prevent the risk of its being stretched or perhaps lacerated; it would at the same time allow of the removal of the very large organ in the readiest manner."[2]

In the majority of the operations performed for disease, the external incision has been along the linea alba. In operations for injury, the original wound has sometimes been enlarged, but in other cases even this has been unnecessary. The length of the incision varies with the size of the organ to be removed, from three inches or less, to ten inches or more. The best incision is that along the linea semilunaris, or that, still further out, employed by Mr. Bryant. All hemorrhage from the parietes having been stopped, and the peritoneum opened, the omentum will probably be found lying over part of the spleen. This must be pushed on one side, and then the hand of the operator should be passed over, above, and on each side of the spleen, to ascertain if any adhesions exist between it and surrounding parts. If any such are found, they must be broken through, with the same care to prevent hemorrhage as in ovariotomy, clamping and ligaturing as their separation is proceeded with. The spleen is next to be raised out of the abdominal cavity, lifting one end, generally the lower, out first. In doing this, precaution should be taken against lacerating the spleen-capsule and parenchyma; the latter is often very soft, and always readily bleeds. The spleen having been withdrawn, a clamp should be fixed upon the pedicle and the mass cut away. The pedicle can now be examined without difficulty, and should be ligatured in two or more parts, with strong, twisted silk or whip-cord; the clamp should be removed, and the ligatures should be cut short and dropped back into the abdomen. All blood should now be removed from the abdominal cavity by means of sponges, which should have been rendered thoroughly antiseptic. Throughout the proceedings, a good assistant must take care that the intestines be not allowed to protrude at the wound. Finally, the external wound is to be closed with interrupted sutures, as after ovariotomy; and the wound should be dressed with some light, antiseptic material, such as boracic-acid charpie, salicylic silk, or absorbent cotton-wool. The abdomen should be supported by a flannel roller. Adelmann proposes to divide the operation into two parts; first, the removal of the spleen from the abdomen through the smallest possible incision; second, after adhesions have formed, and the opening has been thereby closed, to separate the organ from the body.

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[1] Lancet, Feb. 11, 1882.

[2] Guy's Hospital Reports, 3d series, vol. xiii. p. 414.

After the operation, the patient must be kept lying upon his back, with the knees slightly raised by a pillow, and the urine must be drawn off every five or six hours. The dieting should be the same as after every other large abdominal operation.

Dangers of the Operation.—Hemorrhage may occur from a large vessel in the omentum, at a spot where it is adherent to the parietes at the seat of incision; from the rupture of some large vessel, such as the splenic vein; from the torn surface of the spleen itself; or, again, from the general surface of detached adhesions. In Mr. Bryant's second case, hemorrhage from the rotten, sponge-like adhesions which had connected the spleen with the lower surface of the diaphragm, caused death in fifteen minutes. In Sir Spencer Wells's case, a large artery was cut across in a piece of loosely adherent omentum, and afterwards the splenic vein gave way as the operator was twisting the spleen around to bring the vessels into a sort of cord before applying a ligature—a proceeding which this surgeon himself condemns.[1]

In more than one case, a part of the pancreas has been included in the clamp or ligatures applied to the splenic pedicle; this should be guarded against.

Severe disturbance of the sympathetic nervous system has been witnessed in some cases; and severe and persistent vomiting has followed the operation. Attacks of faintness from anæmia have also been observed. As the length of time required for splenectomy is not great—often, indeed, less than half an hour—there is not the risk to life which is undergone, in some other operations, from prolonged influence of anæsthesia, or from prolonged exposure of the peritoneal cavity.

The most frequent cause of death has been hemorrhage, in some period varying from a few minutes to sixteen or eighteen hours. Shock has caused death in other cases during the operation, or within less than twenty hours afterward; and peritonitis has killed a few others in from three to six days.

The cases most suitable for splenectomy or splenotomy are those in which the spleen is involved in an injury, and the gland is, it may be, protruding through the abdominal wound.

When splenectomy is performed for disease, floating spleen, simple hypertrophy, and enlargement from malaria, give the best results. M. Péan successfully removed a hypertrophied gland containing a large cyst; his second case, also successful, was for simple hypertrophy. Martin's (Berlin) and

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[1] Med. Times and Gazette, January 6, 1866, p. 4.

Czerny's successful operations were performed for floating spleen. The question of excision of the spleen for cancer is not likely to arise. It is doubtful if this organ is ever the seat of primary carcinoma, and it is impossible that it should be, if the theory of the epithelial origin of cancer is correct. Quite recently, however, a German has recorded three cases of "primary epithelioma of the spleen," but it is the opinion of others that these cases in no way differ from some forms of lymphadenosis.[1]

For leucocythæmia, whether in the early or late stages, splenectomy should not be performed: first, because the enlargement of the spleen is only a part of a general disease; and, secondly, because there is such a great tendency to hemorrhage that even slight operations upon leucocythæmic subjects should, as far as possible, be avoided.[2] Credé, of Dresden, not only condemns the operation for leukæmia, but thinks the only diseased condition in which it is justifiable, is cystic degeneration of the spleen. He reports a case in which he performed it successfully for this cause in a young man aged twenty-four. In this case, Credé observed that the white blood-cells were increased at the expense of the red, eight days after the operations; that this increase continued for one month, and then was stationary for two months, and that in the fourth month the proportion fell to normal. During convalescence, Credé was unable to detect any enlargement of the lymphatic glands, or any disturbance in the marrow of the bones; but he noticed an inflammatory swelling of the thyroid gland during the fourth month. Credé believes, therefore, that the extirpation of the spleen produces a marked, temporary anæmia, as after severe hemorrhage, and that for a while the thyroid assumes the functions of the spleen, until the system becomes adjusted to its new relations.[3]

That movable spleen is a dangerous condition, and one for which splenectomy is, in severe cases, well suited, may be inferred from Rokitansky's[4] account of it. He gives three cases in which the spleen was found dislocated after death:—

CASE I.—The spleen was in the right iliac region, the pedicle was twisted, and the hilus was turned upwards and outwards; the patient was a woman, aged twenty-eight, upon whom Cæsarean section had been performed. The pedicle consisted of the pancreas, and the splenic vessels, the former making three spiral coils round the splenic artery. The pancreas was about ten inches long, being drawn out and considerably attenuated.

CASE II.—The spleen was in the left iliac region, being attached by a long pedicle to the omentum. It occurred in a microcephalic woman, aged forty-six, who died of tubercular ulceration of the liver and lungs.

CASE III.—The patient was an insane woman, aged sixty-nine; the spleen lay to the left of the upper aperture of the pelvis, attached by false membrane to the sigmoid flexure and coils of small intestine. The splenic artery was elongated and twisted, and its branches were blocked here and there. The vein was blocked. The spleen was the size of a goose's egg, and its capsule was thickened.

Dislocation of the spleen generally occurs in the female, and generally in the direction of the left iliac fossa, and it generally results from tumefaction of the spleen and want of tone in the ligaments. The pedicle becomes twisted during the descent of the organ, and the vessels of the pedicle are narrowed or obliterated. The spleen forms adhesions in its new site, and owing to the interference with the circulation in the splenic vessels, the gland atrophies and degenerates. Death may occur from continued traction upon the fundus of the stomach, or from gangrene of the spleen.

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[1] Lancet, April 14, 1883.

[2] For a concise summary of opinions on the subject, see Mr. Collier's paper (loc. cit., February 11, 1882, p. 222).

[3] American Journ. Med. Sciences, October, 1882, p. 606; Deutsche med. Wochenschr., 10 Juni, 1882.

[4] Zeitschrift der k. k. Gesellsch. der Aerzte zu Wien, No. 3. 1860; Brit. and Foreign Med.-Chir. Review.

As splenectomy is unjustifiable in leukæmia, and yet as the blood of the splenic veins contains a larger proportion of white corpuscles than the rest of the blood, it has been proposed to cut off this excess of white corpuscles by bringing about an atrophic change in the spleen by some other operative measure. Thus it has been suggested that a ligature should be placed upon the splenic artery; but apart from the difficulty of tying the vessel, with the abdomen largely filled with an enlarged spleen, there is the fear that the spleen would necrose and cause death, as in some cases of twisted pedicle with splenic dislocation. Electricity has been locally applied to the spleen, but though the patients so treated have expressed themselves as relieved by the application, and have begged for its continuance, no permanent therapeutical effects have been produced. A diminution in the size of the spleen has been frequently noticed after the application, and in fourteen out of eighteen observations recorded by Dr. Vivian Poore, the number of white corpuscles was increased after the use of electricity. As Dr. Poore therefore remarks, it seems probable that the contraction of the spleen results in a forcing of the leucocytes into the general blood-current, and as the red corpuscles are diminished, it goes to show that the function of the spleen is destructive of red corpuscles.[1]

Another mode of operating upon the spleen in leucocythæmia and hypertrophy, is the injection of drugs into its substance. Hammond obtained rapid reduction in bulk by injecting ergot.

A parenchymatous injection of one gramme of sclerotic acid was followed by death in six hours, and at the post-mortem examination no infarct and only a little reddish zone at one of the punctures was found. The spleen was leucocythæmic.

Mosler, of Greifswald, prefers Fowler's solution to ergot, and has used it successfully in four cases; he applies ice to the spleen before injecting.

Kussmaul, of Strasbourg, tried a repetition of simple punctures with a large needle, hoping thus to produce hemorrhagic infarcts, and a considerable shrinking and reduction in size as the consequence; but the result was disappointing. Galvano-puncture has not been more successful.

Dr. Emanuel, of St. Louis, reports a good result from the internal use of ergot; thirty drops of the extract were given three times a day, and the dose was gradually increased to sixty drops. The patient, a gentleman aged forty-three, had a greatly enlarged spleen, which in a fortnight nearly filled the abdomen; but about ten days after the treatment by ergot was commenced, it resumed its natural size.[2]

Pylorectomy or Partial Gastrectomy.

This operation was first performed by Péan,[3] of Paris, in 1879, but his patient died on the fifth day; the first successful results were obtained by Billroth and Wölfler. The attention of surgeons has since been drawn to the subject by the writings of Anton Wölfler,[1] Mickulicz,[2] Trognart,[3] Rydygier, Gussenbauer, Winiwarter, V. Wehr, Manoury,[4] Czerny, Sydney Jones,[5] Southam, of Manchester, and others.

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[1] Lancet, June 23, 1883, p. 1081.

[2] Ibid., September 30, 1882.

[3] Gazette des Hôpitaux, No. 60. 1879.

Though it has now been performed thirty times or more, the operation still has about it so much of the nature of an experiment—perhaps even of a mere surgical exercise, if one may be allowed the expression—that it is not possible to describe it at present as a thoroughly recognized surgical proceeding. As yet, the surgical mind is not settled either as to the conditions for which the operation should be performed, or as to the precise steps of the operation; or indeed as to the justifiability not to say advisability of its performance.

The Diseases for which Pylorectomy has been proposed.—As yet it has been performed almost exclusively for cancer of the pylorus, but with most disastrous consequences. Twice at least, and successfully, it has been done for simple chronic gastric ulcer; and once, also successfully, for stricture of the pylorus following perforating ulcer. (Heuck, of Heidelberg.) It has been proposed to excise the cicatrix which results from the action of corrosive acids, if the contraction should give rise to pyloric obstruction; and it has further been suggested that in perforation of the stomach with extravasation, laparotomy followed by excision of the diseased structures and cleansing of the peritoneal cavity should be performed. Czerny[6] maintains that "excision of the pylorus ought not merely to be confined to cases of cancer of the stomach, but that a great future is opened up by it for those cases of simple stricture of the pylorus in which an incurable dilatation of the stomach is found. And this is an argument already put forward by Gussenbauer and Winiwarter."

The Operation.—Before the operation is decided upon, the surgeon ought to have satisfied himself as to the nature of the disease, and the justifiability of operating under the conditions of the case in question. The symptoms should point unmistakably to pyloric obstruction. If the disease is not malignant, there should be good grounds for believing that it will, if left alone, assume a perilous character; that the lumen of the strictured part will become less and less, and the gastric dilatation more extreme; and that ulceration, and possibly perforation, will ensue. If the disease is malignant, the tumor should be felt to be freely movable; jaundice, ascites, anasarca of the lower limbs, and every other indication of secondary disease should be absent; and further, the patient's health should not have been so far deteriorated as to render success impossible. In some instances, in which the conditions have been apparently very favorable, they have not turned out to be so when the abdomen has been laid open. The mobility of a cancerous growth of the pylorus, when examined through the parietes with the patient under chloroform, is no proof that the tumor is free from important adhesions. In a case under the care of Professor Lichtheim,[7] the growth was easily moved in different directions, yet on opening the belly it was found to be so firmly adherent that it could not be excised, and the operation was abandoned. The chain of lymphatic glands behind the stomach, at the head of the pancreas, in the omenta and mesentery, may be extensively implicated without giving palpable evidence of disease. The rapidity, too, with which the glands in the neighborhood of the hepatic fissure may be involved, must make the prospect of even a successful operation very doubtful.

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[1] Resectionen des carcinomatösen Pylorus. Wien, 1881.

[2] Journal de Médecine de Paris, 5 Août, 1882.

[3] Journal de Médecine de Bourdeaux, 1883.

[4] Le Progrès Médical, 26 Nov. 1881.

[5] Lancet, Nov. 25, 1882, p. 889.

[6] Transactions of the International Medical Congress, vol. ii. p. 233. 1881.

[7] Brit. Med. Journal, June 3, 1882.

A man under my care in the Middlesex Hospital, with a movable cancerous mass in the pyloric region, consented to the operation of pylorectomy ; his strength and general as well as local condition seemed favorable, and all the final preparations for the operation had been made, when some increased distinctness of the superficial veins of the abdomen, and some slight tumidity in the lumbar regions of the abdominal cavity, as he lay on his back, suggested the advisability of watching and waiting for a day or two. Within a week the whole abdomen was distended with ascitic fluid, the surface veins were greatly enlarged, and the lower limbs œdematous. The patient lingered on several weeks, and died with abundant secondary cancer. It is needless to speculate upon what might have been the result of the operation had it been attempted in this case.

When it has been decided that the case is one fitted for interference, the patient is to be prepared by having the stomach well washed out, and, if the stomach has become much dilated, the washing out ought also to be repeated on the day preceding the operation. The abdominal parietes should be divided, and the peritoneal cavity opened, by an incision four or five inches in length. This may be made in one of three ways: (1) Parallel to the right costal margin (Wölfler); (2) transversely over the most prominent part of the tumor (Billroth and Wölfler), though if this have sunk down very low in the abdomen—as when the pylorus is non-adherent and weighty it will do, even reaching the level of the symphysis pubis—the tumor must be raised before the incision is made over it; (3) longitudinally, in the linea alba (Péan), or a little to the right of it (Rydygier). Sometimes the transverse and longitudinal incisions have been combined before the growth has become accessible, as in Dr. C. Max Richter's case,[1] in which nearly the whole of the lesser curvature was infiltrated ; the transverse incision was five inches long, and about one inch above the umbilicus, while the longitudinal incision was made upwards from the transverse, along the median line to the xiphoid cartilage.

Before the peritoneum is incised, all bleeding points should be secured by torsion or ligature. In the transverse and oblique incisions the hemorrhage from the parietes may be somewhat excessive, and eight or twelve vessels may require to be controlled. Billroth, however, says that Mickulicz considers the transverse incision the best, as it gives more room than an incision along the linea alba, and heals equally as well. The relation of the disease to the surrounding parts is to be made out as soon as the peritoneum is opened, and this is to be done either by introducing the fingers and feeling round the mass, or by withdrawing the mass, when possible, through the external wound. If the growth has invaded, or is adherent to, the pancreas, liver, or transverse colon; if the lymphatic glands in the neighborhood are widely involved ; or if the cancer extends to the second portion of the duodenum, or over the whole or greater part of one of the curvatures of the stomach, the operation should be abandoned, and the parietal wound should be closed. If the abdominal walls are invaded by the disease, the operation may be completed, though with difficulty.

If the operation is proceeded with, the next step is to detach the stomach from the greater and lesser omenta, and for this purpose the stomach is drawn up into the wound, and its walls carefully examined to ascertain at what point they should be cut through. The division of the omenta should then be made step by step, between two pairs of pressure-forceps, ligaturing the cut ends before removing the forceps ; or double ligatures may be passed with an aneurism-needle at short intervals through the portions of the omenta to be divided, and the section made after the ligatures are tightened. Sometimes the thermo-cautery has been employed to divide these structures, but there is no advantage in its use. If any glands are infiltrated, they should be removed at this stage. As soon as the diseased parts have been isolated, a large and properly anti-septicized flat sponge should be placed beneath them, so as to protect the peritoneal cavity, and form a bed upon which these parts may lie whilst they are being cut away. The walls of the stomach are now to be cut through with scissors, commencing at the lesser curvature and making the division obliquely across its surfaces. All bleeding is to be arrested after each stroke of the scissors, and for this purpose many ligatures have been found requisite for the cut edges of duodenum and stomach.

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[1] Am. Jour. Med. Sciences, 1882.

If the stomach is not quite empty, its contents should be soaked up with a sponge specially reserved for the purpose. Mickulicz,[1] following Billroth, says that it is not necessary, after section of the stomach, to close it with Wehr's compressor, because, if care has been taken to wash out the stomach well before the operation, no escape of contents need be feared. Rydygier places his compressors on the stomach and duodenum, and then removes the tumor by dividing the intestinal walls near to the compressors. The pylorus, now held by volsella-forceps, is next to be separated from the duodenum, which should be snipped through stage by stage, in the same careful and gradual manner as the stomach, arresting the bleeding as it occurs. Lest the gut should slip back into the abdomen, a loop of silk should be passed through its serous and muscular coats, below the point of section, and it should be thus gently held by an assistant. A plug of carbolized cotton-wool, or a small sponge, may be temporarily inserted into the open orifice of the duodenum.

With the view of diminishing as far as possible the inequality in the size of the openings in the stomach and duodenum, Wehr advises the enlargement of the duodenal orifice by making an oblique instead of a transverse incision across it. Rydygier, on the other hand, diminishes the size of the gastric orifice by cutting out a triangular piece in the greater curvature, and sewing together the edges of the notch thus made. Billroth closes the gastric opening until it is of the same size as the duodenal. In a case of successful pylorectomy for gastric ulcer, reported by Dr. Van Kleef,[2] of Maastricht, the opening into the stomach was so small that only one finger could be inserted, and it had to be actually enlarged to make it fit the duodenal opening. This is a condition worth remembering when operating for simple ulcer or cicatrix.

The diseased mass having been excised—or, it may be, even before its separation from the stomach is completed—the cut edges of the stomach in part of the length of the wound should be brought together by sutures, care being taken that the serous coats are applied to one another. In attaching the duodenum to the rest of the edges of the wound in the stomach, it is best to begin at their posterior walls. After permanently adjusting the posterior portions, the anterior parts of the stomach and duodenum are to be united. Throughout, the serous surface of the stomach must be retained against the serous coat of the duodenum. Billroth recommends inserting the posterior sutures from the inner surface before the duodenum is completely divided; or several threads may be carried through the walls of the stomach and duodenum to form the posterior "ring suture," and should be held by an assistant whilst the separation of the growth is completed and the occlusion-sutures are adjusted. Either Lembert's or the continuous suture, interrupted and finished off after every four or five stitches, as suggested by Pollock,[3] should be employed. Wehr and Billroth attach great importance to the manner of placing the sutures; and Billroth, before closing the abdomen, examines each suture to see that it is fast. Fine silk, such as the Chinese twist, is a good material for the sutures. Billroth and Czerny used carbolized silk; Rydygier, catgut. The number of sutures required is generally very large, from forty to sixty having often been employed; when the opening in the stomach is very small, fewer sutures will of course suffice. In two cases (one of which was successful) Billroth stitched the duodenum to the lesser curvature, and closed the gastric orifice by transverse sutures. He thinks, however, that there is less traction on the stomach, and a more direct passage from the stomach to the duodenum, if the gut is fixed to the greater curvature. This plan he adopted in his third case. The wound in the parietes should be closed by interrupted sutures passed through all the layers of the walls, including the peritoneum. Boracic charpie, salicylic wool, or absorbent cotton-wool, should be bandaged over the front of the abdomen, and the patient placed in bed upon the back, with the knees raised.

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[1] Journal de Méd de Paris, 5 Août, 1882.

[2] American Journ. Med. Sciences, April, 1883, p. 582.

[3] Holmes's System of Surgery, 3d ed. vol. ii. p. 742.

After-treatment.—For the first twenty-four or thirty-six hours, or longer if possible, the strength of the patient should be sustained by nutritive enemata given every four or six hours. Each enema should consist of two ounces of strong beef-tea, half an egg, and a drachm of brandy, with a little opium if required. The mouth may be moistened from time to time with a teasponful of iced water or fresh milk. After the first twenty-four hours, the patient may commence to take fluid nourishment in small and frequently repeated doses, and by degrees a light solid diet may be permitted if all goes well. Van Kleef's patient ate beef-steak on the tenth day. Czerny's patient took meat on the fifth day, and was up on the twentieth.

Duration of Operation and Extent of Parts removed.—No one must undertake excision of the pylorus without being prepared for a long and tedious operation. The shortest time occupied has, I believe, been one and a half hours. Most cases have taken from two to three hours or more, and some have occupied at least five hours.

The extent of stomach removed varies of course with the extent of the disease; but it has amounted to five inches and more along the greater curvature, and three or four inches along the lesser. In one case, nearly the whole of the lesser curvature was implicated and removed; but the patient died in three hours. The weight of the mass removed in Lauenstein's case is stated as about nine and a half ounces. In Wölfler's[1] case, the tumor, when removed, was the size of an apple. The patient did well.

Dangers of the Operation.—The complicated anatomical relations of the pylorus, the size of the viscera divided, the unavoidable tediousness of the manipulations, and the consequent prolongation of the anæsthetic state, must always cause pylorectomy to be one of the most formidable and exhausting, as well as difficult operations. Shock and collapse have been the most frequent cause of death; and hemorrhage, more especially when secondary, is a source of great danger. Peritonitis has not been a frequent complication. In one case (Lauenstein's), a large portion of the transverse colon mortified; adhesions had existed between the posterior surface of the stomach and the transverse meso-colon, and had had to be ligatured and divided; and in this way, probably, by the cutting off of the arterial supply, gangrene of the bowel ensued and killed the patient about the eighth day. Probably the greatest difficulty in the operation is the separation of adhesions. In the small number of recorded operations, the character of the adhesions found has been widely different. Besides the pancreas and colon, the vena cava and vena portæ have been found adherent to the growth. In Billroth's third case, the pyloric cancer was attached to the pancreas, and about one hour was occupied in isolating it; the entire operation took two and a half hours. The patient died the same evening, and cancerous glands were found near the head of the pancreas, and in the lesser omentum. The frequency with which adhesions will be met with may be inferred from Gussenbauer and Winiwarter's statistics. These show that out of 542 cancers of the pylorus observed at the Pathological Institute of Vienna, 370 had adhesions.

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[1] Edinburgh Med. Jour., November, 1882.

The mortality of pylorectomy or partial gastrectomy has been very high. Out of 29 cases, the operation has been performed in 27 for tumor of a malignant nature, and has been fatal in 23 of these. In two cases (Heuck's, of Heidelberg, and Van Kleef's, of Maastricht), the operation has been done for gastric ulcer of a non-malignant type; and in both instances with perfect success and permanent recovery.

Thus 6 out of 29 patients have recovered from the operation. Of the 4 with malignant disease, 2 (Wölfler's and Czerny's) were known to be alive and well, without any symptoms of recurrence, many months (6 and 10 respectively) after the operation; one (Billroth's first patient) died four months after the operation, with cancerous disease of the peritoneum and retro-peritoneal lymphatic glands. Of the 23 fatal cases, none lived longer than eight days, and in most death resulted from the operation within a very few hours. [Of 32 cases to which the editor has references, 11 are said to have ended in recovery.]

With these results before him, I must leave the reader to form his own opinion as to the justifiability of the operation for malignant disease. For my own part, given a suitable case in a patient not too far worn out by his malady, I should feel justified in offering him the chance of prolongation of life which the operation might afford, and in performing the operation, if desired, after fairly acquainting the patient or his friends of its risks; but with my present knowledge I should not feel justified in advising the operation. In simple stricture of the pylorus, if incurable dilatation, with obstruction, exists, the operation seems to me to be not only justifiable but advisable.

Other Operations on the Stomach.

Gastro-enterostomy is an operation which has been proposed for those cases of cancer of the pylorus in which excision is not possible. It was performed for the first time by Dr. Anton Wölfler, in Vienna, and has since been repeated by Billroth. This mode of treatment appears to have been devised on the spur of the moment, after an exploratory incision had been made into the abdomen of a man who was suffering from cancer of the pylorus, and in whom the operation for removal of the tumor proved to be impossible.[1] It consisted in making an incision into the stomach near the middle of the great curvature, and a similar cut into a coil of small intestine—probably as near as possible to the commencement of the jejunum—and carefully sewing to one another the margins of the two openings thus formed. The object of the operation was thus twofold—in the first place to allow the materials swallowed to pass into the intestine; and in the second place, to prevent any obstruction to the escape of the biliary and pancreatic secretions. Strict antiseptic precautions "with the exception of the use of the spray" were observed during the operation, and not only did healing take place without any fever and by first intention, but the patient experienced very marked relief, and at the time of the report had survived the operation nearly four weeks. Not only had he survived, but a marked improvement had taken place in his symptoms; the vomiting had stopped, and he had been able to take increasing quantities, first of fluid, and afterwards of solid food. He had also had daily evacuations of the bowels, the stools being firm and brown.

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[1] Centralblatt für Chirurgie, 12 Nov. 1881.

Billroth's case was also one of cancer of the pylorus, too far advanced for removal. The operation was apparently carried out in the same way; it was easy of performance, and lasted only an hour. The patient, however, was seized with biliary vomiting, which continued till he died on the tenth day. An explanation of the vomiting was found after death: there was no peritonitis; but the result of drawing the intestine towards the stomach had been to form a spur which divided the opening between the two viscera into two unequal parts, the larger of which communicated with the proximal portion of the intestine. The result of this was that the bile and pancreatic secretion, instead of passing into the intestine, were poured into the stomach, and the consequence was that which has been described. The author points out the necessity of making sure, to begin with, which is the proximal, and which the distal portion of the coil of intestine selected, and then of taking care that a thoroughly free communication shall exist between the latter and the stomach, while the former shall be, in a way, valved by making the stomach-wall overlap it. He also suggests that this method of procedure may possibly prove of value in cases of malignant growth in connection with the intestine.[1]

DIGITAL DILATATION OF THE PYLORUS.—Professor Loreta, of Bologna, has proposed and performed forcible dilatation of the pyloric orifice in [four] cases of simple stricture. A longitudinal incision through the abdominal parietes on the right of the linea alba, enabled the surgeon to reach and draw forward the stomach, which was then incised near to the pylorus. Through the gastric wound, the right index finger was passed on through the pylorus, after forcibly dilating it. The wounds were then closed in the usual manner. Complete relief followed the operation in [three] cases, and the first patient is known to have been alive and in good health five months after the operation, but how long the improvement was maintained is not known. [Death followed in one case, as it did in another in which Giommi was the operator.] It is a measure which, for simple strictures, seems to offer a fair prospect of success.

The following is the report of Prof. Loreta's first case, as given in the Lancet of August 18, 1883, p. 289.

Nicola C., aged 47, had suffered for the greater part of twenty years from imperfect digestion, distension of the stomach, sense of weight, and occasional vomiting. In 1878 he had been admitted into the Bologna Medical Clinique, and treated for ulcer of the stomach. Relief had ensued, but only for a short time. Eructation, a burning feeling in the throat, vomiting of undigested food, sometimes mixed with blood, increasing emaciation, and pallor of the skin and mucous membranes were noted. The man subsisted on a little milk. The distended stomach gave a clear note on percussion, from the fifth rib to the umbilicus. Microscopic examination of the fluid drawn by pump from the stomach yielded no evidence of organic lesion. On palpating the emptied stomach, a tumor could be felt in the pyloric region, with smooth and elastic surface, but not very well defined limits. As the patient was steadily sinking, Professor Loreta, on September 14, 1882, operated in the presence of numerous colleagues. Dr. Alfonso Poggi administered chloroform; the stomach was washed out with an alkaline solution; the incision into the abdominal wall was commenced a little to the right of the linea alba, and extended outwards and downwards for six inches; the lower angle was an inch and a quarter from the ninth right costal cartilage. In the incision were included the oblique and transverse muscles, and also a part of the rectus. On reaching the peritoneum the Professor stopped to tie some arteries and to await the complete arrest of bleeding from the edges of the wound. The peritoneum was then opened. The omentum was extensively adherent by old inflammatory exudations. These were separated very slowly and carefully from the abdominal wall and from the surface of the stomach. This viscus was then drawn out through the wound, and the operator felt the pylorus much enlarged and of fibrous hardness.

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[1] The foregoing account of the operation is taken from the Medical Times and Gazette, December 3, 1881.

In the space between the two curves of the stomach, and at a distance of an inch and a quarter from the pylorus, an opening was made into the viscus with a stout pair of scissors, through a transverse fold previously raised. The opening into the stomach was extended two inches and a half, and T-shaped forceps were used to arrest bleeding from the edges. The right index-finger was then passed into the stomach towards the pylorus, which was completely closed. The finger failed to pass into the duodenum in spite of considerable pressure and combined lateral and rotatory movements. The left index-finger was then introduced into the stomach, and used to fix the pylorus, while strong and renewed pressure was exerted to push the first phalanx of the right index into the narrow and contracted pylorus, which was then drawn forwards to the external wound. Along the right index-finger the left one was also introduced into the pylorus, but these attempts failed to pull one finger from the other, in spite of much force, sustained as long as possible (" moltissima forza, nel sostenerla quanto piu a lungo potessi"). After resting, the operator resumed his efforts and dilated the pylorus, though he only succeeded in doing so very slowly, and by employing very great force. The dilatation was continued to about three inches (eight centimetres). The stomach wound was then sutured with carbolized silk, the viscus replaced in the abdominal cavity, and the external wound closed with seven silver sutures. The patient was returned to bed thirty-three minutes after the commencement of the operation. On regaining consciousness the patient complained only of thirst, and of a slight burning sensation at the wound. Small pieces of ice were given from time to time. In the afternoon the patient complained of weakness and hunger, and relished the yelk of an egg beaten up with Marsala wine, given in teaspoonfuls every half hour. The temperature throughout the day was 98° F., pulse 72, respiration 26. The same kind of diet was continued. The third day after the operation the bowels acted after an enema; the fourth day, some broth and light paste were allowed; the fifth day, some chicken; the sixth day, bread was added to the diet. On that day the bowels acted spontaneously. The wound was first dressed on the eighth day, and five sutures removed. The incision had healed by the first intention. The two remaining sutures were removed on the eleventh day. The thirteenth day after the operation the patient's diet consisted of coffee and milk, bread, roast chicken, roast beef, eggs, and wine. He was out of bed for two hours and a half on the sixteenth day, and rapidly gained flesh and strength. Two days before the operation the man had weighed 122 pounds, and he gained about 33 pounds in six weeks. He continued to enjoy perfect health when presented to the Bolognese Academy, after the lapse of five months.

[DILATATION OF THE CARDIAC ORIFICE of the stomach has since been performed by Professor Loreta, and with equal success.]

OPERATIONS ON THE PANCREAS AND LIVER.

Extirpation and excision of the *pancreas* and of the *liver* have not yet been brought within the category of surgical operations, except in cases such as have been referred to in other parts of this article, in which parts of the liver protruding through a wound of the abdominal walls have been ligatured and cut away, or more or less of the pancreas has been excised, with large pancreatic cysts or cancers of the pylorus.

Some experiments, made on animals, of removal of parts of the liver by means of elastic ligatures, have been recorded, but they give little if any promise of success. Indeed, for the most part, the experiments have resulted in complete failure.

HERNIA.

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Hernia in General.

In its more extended meaning the term *hernia* is applied to any protrusion of a viscus through its containing walls, as seen in Hernia cerebri, Hernia pulmonum, Hernia testis, etc. In its more restricted and usual sense, it means a protrusion of some abdominal viscus through the abdominal walls, beneath the integuments and fasciæ; and in this sense it is used in this article. Most frequently the opening is constituted by the enlargement of a natural aperture between the muscles and fasciæ. Such protrusions are named according to their situation: *Hernia inguinalis*, *Hernia cruralis vel femoralis*, *Hernia umbilicalis*, *Hernia obturatoria*, *Hernia sacro-sciatica*. All these pass through dilatations of natural openings, and are covered by the integuments and abdominal fasciæ varying with their position. In the same category must be named the unusual forms of diaphragmatic hernia passing through the œsophageal openings into the thorax. But abdominal rupture is sometimes found as the result of wounds, or tearing of the abdominal walls. This most usually results in a *ventral* hernia, occurring through openings in the musculo-tendinous parietes, produced by distension and forcing, such as occurs in pregnancy and childbirth, and in excessive corpulency, peritoneal dropsy, etc. Another form of traumatic rupture, as it may be called, follows penetrating wounds in the same regions—as in the case of diaphragmatic protrusion through a spear wound into the pericardial cavity, protrusion after laparotomy, etc.

Beneath and in addition to the coverings already mentioned, herniæ are also usually furnished with a *sac* or covering of the serous membrane—the parietal layer of the *peritoneum*; but the cæcum may protrude without a sac, and in cases of congenital umbilical hernia, and of traumatic rupture, the only sac to be found may be composed of cicatricial tissue. This containing pouch soon contracts adhesions to its hernial coverings, and cannot after a time be returned within the musculo-tendinous walls of the abdomen. It increases with the size of the protrusion, partly by growth, partly by distension with slight unravelling of its fibres, but mainly by fresh protrusion of the loose peritoneum. It may be so thin as to be distinguished with difficulty, or so thick as to be divisible into layers. The dilated end is called the *fundus*; the narrow constricted portion is the *neck* of the sac. In an old rupture, the latter is usually puckered, thickened, and more or less rigid, sometimes forming a strangulating band. Sometimes two sacs are found in an old hernial tumor, a fresh protrusion existing within, or by the side of, the primary sac; or the sac may be constricted into two narrow, neck-like apertures (*hourglass* contraction), each resisting and capable of strangulating its contents. In the sac may be found almost any portion of the abdominal structures, even parts of the liver, kidney, or ovaries. The contents vary with the higher or lower position of the protrusion. In the greater number of cases, the intestine and omentum, or epiploon, form part of the contents (*entero-epiplocele*); but sometimes, in inguinal and crural hernia, the omentum forms the sole contents (*epiplocele*), or the intestine only may be found in the sac (*enterocele*).

FREQUENCY OF HERNIA.—Abdominal hernial protrusions are very common. According to Malgaigne, one out of every 13 males, and one out of every 52 females, are affected with some kind of rupture; that is, about one in every 20 individuals. Of these, more than half are found between 40 and 80 years of age. In Kingdon's tables, from reports of the Truss Society, farmers and farm-laborers are most subject to hernia of some form; next come porters and gardeners, then carpenters and house servants.

It is significant that all these occupations necessitate the frequent use of muscular power with the body in a bent position on the legs.

GENERAL CAUSES OF HERNIA.

In by far the greater number of cases of inguinal and umbilical hernia, the occurrence of protrusion is preceded by a condition resulting from arrest or delay of development, delaying the descent of the testicle beyond the time of birth—when the body of the child becomes reversed from an inverted to a more or less upright position—and retarding the complete formation of the transversalis, internal oblique, and cremaster muscles, the closure of the deeper opening being imperfectly effected, or the omphalo-mesenteric and allantoid openings being later in closing up than usual. Then the first efforts of the new-born infant, in crying and breathing, force out the smaller intestine, while undistended with food, into the patulous passage, and retard or prevent its normal closure. In many cases in which the formative tendencies are rather more effectual, but still not complete, a bulgy condition of the groins, or of the umbilical dimple, remains during life, although the absence of other exciting causes may not effect a complete hernial condition. An important predisposing cause was pointed out by Richter, in an abnormal elongation, or low attachment, of the mesentery and omentum. This operates in the case of inguinal and femoral ruptures by allowing the omentum, mesentery, and intestine, to reach further down than is normal, and gives them liberty to force open the inguinal and femoral openings under pressure of the muscles. And it must be admitted that such a condition forms a powerful aid to the production of hernia in these situations. But that a normal formation and normal connections of the mesentery and omentum will not prevent the protrusion of intestines, is witnessed in the performance of the operation of abdominal section, or in accidental penetrating wounds just above the pubis, where the opening is quite as far down as the inguinal opening, and yet where protrusion occurs immediately upon contraction of the abdominal muscles. And on the other hand, such abnormal connections and elongations are frequently found in the post-mortem room, in persons of advanced years, in whom no hernia is found. These crucial instances show that when the abdominal parietes are normal, the pressure of the abdominal contents, however unrestrained by the connections of the viscera, are not sufficient of themselves to cause hernia, although they may constitute an important subsidiary element in its production when the abdominal apertures are weak or patulous. When a rupture is established, the downward traction tends of course to produce or increase such an elongation, and results in the development of the various tail-like formations which are so often found in the omentum lodged in an inguinal or femoral rupture.

All these causes are more or less the result of *hereditary formation* of the belly and of its contents. Bulgy groins, late-descending or retained testicles, and inguinal, crural, and umbilical hernial protrusions, can be traced so frequently in the several generations of the same family, as to set this beyond a doubt.

Another powerful factor in the production of hernia, operating earlier and more easily in individuals predisposed as just described, and later and with more difficulty in those who are perfectly formed, lies in the nature of their pursuits and occupations. Forgemen, strikers, carpenters, and colliers are all especially liable to ruptures, as are those who inordinately practise such athletic exercises as rowing, lifting heavy weights, etc. In some cases the debilitating effects of a high temperature in the working atmosphere, helps the predisposition by causing relaxation of the skin and other tissues. In others, the position of the body, as in bending, crouching, or sitting, while making great muscular exertion, prevents the lower abdominal muscles, the oblique and transversalis, from giving the proper support over the openings during the supreme effort. Very commonly, the constant and great expulsive efforts in a chronic cough, violent sneezing, straining at stool, or during micturition, result in a rupture. Again, the excessive distension produced by corpulency, and still more that caused by pregnancy, followed by the violent expulsive efforts of parturition, frequently causes a hernia, usually of the umbilical or ventral variety.

General Signs of Hernia.

One of the most characteristic signs is the sudden appearance of a tumor near one of the openings just enumerated—a tumor which shows itself on assuming the erect posture, increases on making any muscular effort, disappears on lying down, and is usually absent after rest in bed. The tumor gets larger, tenser, and more elastic on coughing; and this cough-impulse, felt by the fingers firmly grasping the tumor, is one of the pathognomonic signs most relied upon.

A hernia containing omentum only, feels inelastic, flabby, and uneven to the touch. It is returned into the abdomen with more difficulty than one containing bowel, and may easily be mistaken for a varicocele, but is less elastic. When reduced, if the finger is kept pressed upon the hernial opening, and the patient stands up, no return of the swelling occurs; but in a varicocele the pressure promotes the quick return of the swelling by obstructing the venous circulation.

A hernial tumor can usually be squeezed back into the abdominal cavity by the proper application of the fingers (*taxis*): except in cases to be mentioned hereafter, it is compressible and reducible. None of the signs mentioned can, however, be relied on singly in any doubtful case. Any fluid accumulation lying within the influence of the abdominal muscles, will become more prominent on standing, will have a distinct cough-impulse, and may be pressed back. This sign ceases, for example, to be a distinguishing mark in the diagnosis of femoral hernia from psoas abscess, or in that of inguinal hernia from abdominal abscess or from hydrocele of the cord. But if added to the above signs we have a ventral resonance on light percussion over the tumor, from the presence of air in the contained intestine, we have an important verifying evidence.

But this corroboration will not be found in herniæ containing omentum only, or any other of the solid viscera, and so cannot help to distinguish them from an enlarged gland or a tumor. So that in many cases the concurrence of signs, aided by the method known as diagnosis by exclusion, will be the only safe guides to an operative procedure, and some cases can only be made certain by careful explorative dissection. In hernia containing intestine, the occasional occurrence of the croaking, gurgling, or squeaky sounds of air mixed with fluid (technically known as *borborygmus*), especially heard and even felt when pressing back the contents, will make clear the diagnosis. Again, interference with the known functions of any viscus which is implicated, such as flatulence, nausea, or constipation of the bowels, and signs of irritation of the bladder or ovaries, or absence of the testicle from the scrotum, may throw light upon the case.

In the formation of a rupture, pain is usually, but not always, felt—a sudden and violent pain when fibres give way or strangulation is threatened, a dull, aching, intermittent, and recurring pain, or soreness, when the distension of a natural canal is occurring. When the bowel is fairly engaged in the hernial opening, to these are added a dragging pain felt in the lumbar region, or about the umbilicus, flatulent eructations, uneasiness after eating, constipation, and even nausea and vomiting, from traction on the stomach. These symptoms, in ordinary cases, gradually disappear on the patient lying down, but increase in intensity if the case goes on to complete strangulation. In some slow cases, no pain whatever is felt in the part during the formation of the hernia, and the attention of the patient is first attracted to it by the appearance of a tumor.

In most cases, the commencement of the rupture is due to a portion of omentum being first forced through the deep ring, and gradually preparing the way for the entrance of the bowel; and in some cases, a small tubular formation of the peritoneum (the persistent remains of the canal of Nuck) favors the entrance of the omentum. Such cases are usually unattended with pain, or have but little, in their formation. In other instances, the small intestine may be the first to force open the deep ring, producing a good deal of aching and acute dragging pain in the groin, and symptoms referable to irritation and irregular contraction of the intestines, such as flatulence and alternating diarrhœa and constipation.

The increase of an *epiplocele* is slower and more gradual than that of an *enterocele.* This variety is less commonly observed in femoral than in inguinal, umbilical, or ventral hernia. It is less easy to detect and to differentiate from other tumors, is doughy and inelastic to the touch, and dull on percussion, while enterocele is elastic and resonant; the cough-impulse is less marked and evident, and its reduction is effected more slowly, and without gurgling or borborygmus, such as we usually have in enterocele. Most cases have, however, mixed contents of both omentum and bowel, and sometimes in the lower part of the sac the hernia has the characteristics of an epiplocele, and in the upper part those of an enterocele.

The protrusion of a hernia is brought about by violent efforts of expiration by the diaphragm and abdominal muscles, pressing outwards the contents of the abdominal cavity. The investing structures give way at their weakest part, wherever that may be at the moment. The protrusion is often favored by the position of the body at the time of the supreme effort. If the thighs are bent on the trunk, the tendinous structures in the groin are relaxed, and the muscular fibres which are attached to them operate at a disadvantage, and leave unsupported the openings which they should cover and protect. The result is some form of *inguinal* or *femoral* hernia. If in addition there is a congenital or traumatic imperfection in the development or position of the abdominal muscles and fasciæ, the result is more easily effected. So if the abdominal recti be imperfectly developed, and separated by a broad linea alba, while the umbilical cicatrix is large, weak, and feebly resistant, the result is an *umbilical* or *ventral* hernia. Or if any other of the natural apertures of the abdominal cavity are looser and less compact than natural, or if by the infliction of an injury a cicatricial tissue has been formed which is more yielding than the normal walls, the protruding force operates in the manner of fluid pressure, and the weakest part gives way. In some of these cases, where no parietal peritoneum is opposed to the opening, there may be no serous sac formed for the protrusion, which is covered only by the enveloping fascia of the part.

The forces above indicated operate alike in all cases of abdominal hernia. The particular form which it may assume is determined by the condition of the several abdominal apertures. In some cases met with, the tendency is so extensive that several herniæ may occur in the same person, more or less closely following each other, or even produced at the same time. Thus, it is not uncommon to find a double inguinal rupture, associated with a femoral or an umbilical one, or even both. In such cases, it is found that the mesenteric and omental connections are long and loose, or that the patient, after having been stout and corpulent, has become suddenly, by illness or other causes, thin and relaxed. The fat which helped to fill up the apertures is removed before it disappears in the mesentery and omentum, where it increases the protruding force. Another condition which predisposes to the formation of rupture, is irregular contraction of the large or small intestine, as from flatulent colic, with distension of one part of the bowel, and spasmodic contraction of the neighboring part. The former distends the abdomen, and helps to force the smaller contracted portion through the hernial aperture. This is perhaps most frequent in children, from the same causes which may eventuate in intussusception of the bowel or prolapse of the rectum.

Reducible Hernia.

If the contents of a rupture can be returned into the abdomen by pressure (*taxis*), or go back of themselves, it is called a *reducible* hernia. Usually the reduction may be effected by simple posture, as by lying down for a greater or less time, and especially if the pelvis be raised above the upper part of the trunk, as by inversion of the patient. Under these circumstances the contents are drawn into the abdomen by the simple force of gravity, facilitated by the smooth, moist, and slippery surfaces of the peritoneum. Frequently we see the hernia thus reduced by the peristaltic contraction of the longitudinal muscular bands of the intestine, or by the flatulent or other distension of the gut in the close neighborhood of the contracted part which lies in the hernia, or by the rolling movement of the stomach and large bowel, acting through the great omentum. In some cases reduction seems to be effected or aided by the bracing and compressive action of the cremaster and dartos fibres, when stimulated by a dash of cold air or water, or by the application of ice.

Irreducible Hernia.

When the hernial contents cannot be returned by the above means, although there be no impediment to the passage of feces through the bowels, or to the circulation of blood through its vessels, the rupture is said to be *irreducible.* This condition may be produced 1, by the adhesion of the contents to the sac, or to each other, so as to prevent the serous surfaces from sliding over each other, or by the formation of membranous bands; 2, by the enlargement of the omentum or mesentery by deposition of adipose tissue, or from fibroid or glandular change in these structures, usually resulting from truss pressure (*incarcerated hernia*); and 3, in the case of omental hernia, by atrophy of the upper part which lies in the neck of the sac, causing it to double up easily on force being applied. Irreducibility produces dragging pain in the abdomen, and sometimes nausea and vomiting, flatulent distension, and constipation from irregular peristaltic action, all increased by corpulence and pregnancy. The protruded parts are also exposed to injury, and are in constant danger of strangulation and inflammation.

Irreducible ruptures may sometimes be made reducible by keeping the patient in bed for some weeks or months, and by reducing the diet so as to cause absorption of the fat. And when this has been done in the course of a long illness, irreducible ruptures have sometimes spontaneously disappeared.

A large enterocele may be rendered temporarily irreducible, by an accumulation and impaction of hardened feces in the contained intestine preventing the progress of the intestinal contents wholly or in part (*infarcted hernia*). This condition is invariably attended by more or less constipation of the bowels, and may even give rise to the more severe symptoms of obstruction, such as nausea, and vomiting, even of a fecal character. Copious enemata of gruel, olive oil, and turpentine, regularly administered three or four times daily, with the recumbent position aided by the topical application of hot fomentations, will usually help the taxis to a successful issue in such cases.

The regular use of laxative enemata, with the application of ice-bags and elastic, compressing apparatus to the tumor, will help to relieve all these forms of irreducible hernia. Sometimes it happens that the patient is made so uncomfortable and ill by the return of an old irreducible hernia, that the reproduction of the protrusion is desirable to relieve him. Efforts at reduction are most likely to succeed in the omental forms. But when there are adhesions, it is evident that the measures above described cannot succeed, and if the sufferings or disability resulting from an irreducible rupture justify the risk, the modern practice, hereafter described, of opening the tumor under the carbolic spray, and antiseptic dressing, may be had recourse to. The palliative plan of applying a bag truss to receive and support the rupture, may be sufficient to relieve the patient whose physical condition or age forbids such an operation.

Strangulated Hernia.

A hernia is said to be strangulated when it is constricted at the neck with such force as to obstruct the circulation of the blood in the vessels and to paralyze the nerves, as well as to stop the passage of secretions and feces through the contained bowel. The former condition may exist, and set up its characteristic symptoms, in cases of omental and other herniæ which do not contain bowel. The results depend upon the severity of the constricting force. If it be so complete as to stop all the circulation in the compressed parts, either by its immediate pressure, by the progressive coagulation of the blood, producing thrombosis in the vessels less immediately compressed, or by the results of inflammatory stasis, the result is complete gangrene or mortification of the parts engaged. If it be less complete, the result may be linear ulceration of the parts immediately compressed, and progressive separation of the tissues. If any part of the bowel be included, it may thus become perforated, and may give exit to the alvine matter or mucus which it contains. This may, according to its position, either escape into the peritoneal cavity and set up local or general peritonitis, or be retained in the sac, causing it to suppurate.

General Symptoms of Strangulation.—These may be separated into the symptoms of *obstruction*, which indicate the stoppage of the passage of the intestinal contents, and those of *strangulation proper*, which indicate arrest of the local circulation and pressure upon the nerves. Both are common to hernia and to various other pathological conditions. The former are usually slower in development, and more chronic in continuance, while the latter are more acute, intense, and alarming to the patient. Thus the symptoms of obstruction may result from intra-abdominal pressure by various tumors, from adhesions, from impaction of feces, or from calculi. They can occur only where the intestinal canal is directly implicated. Those of strangulation may result also from intra-peritoneal causes independently of rupture, such as the sudden entanglement of the bowel in bands of adhesion, forming loops or openings in the mesentery or omentum, through which the bowel may be suddenly thrust. On the other hand, they may occur without complete obstruction of the bowels in ruptures, as where the omentum only is present in the sac, and is strangulated without implication of the bowel in the constriction.

The *signs of obstruction* are persistent *constipation*, and eventually total cessation of the alvine evacuations. One or more costive evacuations of the contents of the bowel below the obstructed part may occur, after the first symptoms have manifested themselves, and are usually attended by tenesmus and straining. If these evacuations are in fair quantity, the position of the obstruction may be localized as being somewhere above the large intestine. Gradually the abdomen becomes distended, and flatulent eructations and borborygmus occur, the flatus rarely if ever passing downwards by the anus. The distension of the bowel may, in thin persons, often be traced on the surface of the abdomen, and is slowest and most pronounced in obstructions low down. Colicky pains, more or less severe, follow from spasmodic peristaltic movements. These ultimately become reversed in order of occurrence, and project the fecal matter towards the mouth. Then occurs *vomiting*, at first of the just taken and unaltered food, then of the chymous ingesta and the acid, gastric secretions, then of chyle more or less tinged with bile, and finally of matter possessing a decidedly fecal smell and appearance. In cases of acute strangulation, the vomiting and sickness take place almost immediately, attended with much pain from the sympathetic irritation of the gastric nerve-centres. As a rule, the vomiting occurs earlier in the sequence of symptoms the higher the point of obstruction. The pain increases in intensity, is not referred with certainty to a particular spot, but follows rather the curve of the bowel around the umbilicus, to which it is vaguely referred. The secretion of urine may be limited, and this has been said to indicate a high position of the obstruction; but the amount of urine depends so much upon that of the perspiration, and upon the quantity of fluids swallowed, that the indication is of little practical value.

In the earlier stages, the *temperature* of the patient is usually normal; afterwards it may rise somewhat at night, to fall in the morning often below the natural average; and at the same time the *pulse* quickens and is more compressible. In the later stages the temperature often falls considerably, and may remain below the normal standard, while the pulse quickens to 120 per minute or more, and becomes more feeble, and at last irregular and intermittent. The *respirations* are quick and shallow, and entirely thoracic. The vomit becomes more constant, and is darker from admixture of extravasated blood, and at last looks entirely like coffee-grounds; the secretions fail, restless sleeplessness ensues, the pain ceases, the countenance becomes pallid, sallow, and sunken, a cadaverous smell mingles with the fecal odor of the breath and body, and the patient dies from exhaustion at a period varying from a few days to many weeks. Post-mortem examination usually reveals more or less of the results of peritonitis, general, or limited to the region of obstruction.

The *symptoms of strangulation* may in great part be referred to those of peritonitis, at first local in extent, finally general. If the constriction be severe, or near the upper part of the canal, the pain and distress are quickened and intensified on the first onset by the pressure upon the numerous nerves of the part, and by sympathetic irritation of the epigastric nerve-centres. There may be very early and severe symptoms, causing speedy death—apparently by the impression of the pain upon the nervous system generally, resulting in exhaustion—without any extensive post-mortem appearances of peritonitis. In these cases the pain and distress come on directly after the occurrence of strangulation, and soon become intense, the temperature and pulse rise together, the countenance is pale and very anxious, and the decubitus dorsal, with the knees drawn up to relax the pressure of the abdominal muscles. The respirations are short, quick, shallow, and entirely thoracic; and there is usually an unequal, one-sided, spasmodic contraction or catch in the abdominal muscles. The pain is attended by a dragging sensation, and is referred constantly to one spot. In cases of hernia it directs the surgeon to one of the usual hernial openings, where a hard, elastic, tense, and very tender lump, of greater or less size, is found. The cough-impulse in the tumor is wanting when tested. The less common, deeper-seated herniæ, such as the diaphragmatic, sciatic, and obturator, where the tumor cannot be felt, may be suspected from the position of the pain, and from the effect upon the action of the diaphragm, or upon the nerves, sciatic or obturator, pressed upon by the tumor. In other respects than the latter, they resemble obscure cases of intra-peritoneal strangulation. The inflammatory symptoms of strangulation consist of the constitutional, feverish symptoms—such as a rise in the temperature, quickened pulse and respiration, diminution of the secretions, and foul tongue —which characterize pyrexia. The temperature rises in the evening, and falls in the morning, after daybreak. The rise does not usually reach as high as in traumatic injuries of the head; from 102° to 105° F. is the usual limit, with exceptional cases; and the fall is usually proportionate to the rise. The pulse reaches its danger point at 120, and increases in quickness as the case approaches a fatal end. It is always soft and compressible, a peculiarity which seems to be caused by the impression made on the extensive abdominal nerve-centres, and secondarily upon the cardiac plexuses. To the same cause must be attributed the constant vomiting, the stomach rejecting all food, and the retching commencing earlier and more violently than in mere obstruction. The anxious face is often yellow or jaundiced, the decubitus dorsal, with the knees drawn up, and the breathing short, quick, and thoracic.

The *local symptoms* are great pain, commencing in and usually referred to one spot, but ending in a twisting and dragging pain around the umbilicus, as the inflammation extends to the coils of intestine. There is general abdominal tenderness, especially acute as the pressure nears the strangulated point. Very soon, swelling of the abdomen and tympanites on percussion, evidence paralysis of the intestinal muscles and accumulation of flatus and liquid excretions, attended by the borborygmus and other signs of obstruction already described. The symptoms are less severe when the omentum only is constricted: there is then no total obstruction, but rather irritation of the bowels.

When the vessels of the constricted part are completely obstructed, and its nerves of sensation paralyzed, it becomes mortified, the pain ceases, and the patient becomes easier and less restless. But the temperature falls suddenly; the pulse becomes quicker, weaker, irregular, and intermittent; and the breathing is more shallow, as the abdominal swelling increases and prevents the descent of the diaphragm. The face is still anxious and pale, and becomes more and more livid, and covered with a cold, clammy sweat; the eyes film over, and are glassy; the voice is hollow; the tongue and mouth are dry, cracked, and covered with a brown sordes, and sometimes an eruption forms on the lips. The breath is cold, and the smell of the patient cadaverous. All these signs indicate, and are speedily followed by, death. The post-mortem examination shows great distension and softening of the bowels above the strangulated part; congestion of all the peritoneal vessels, most intense in the neighborhood of the strangulation; frequent and extensive ecchymosed patches; effusion of pus, and often of putrid fluid, with flakes of lymph, and more or less extensive adhesions of the coils of intestine to each other, and to the mesentery, omentum, and parietal peritoneum. These adhesions, usually soft and recent, are sometimes continuous near the site of strangulation, so that the loop of bowel often cannot without difficulty be separated from the constricting part, and the intestinal walls are so softened as to be easily torn in attempting it. Sometimes an ulcerated opening may be found at or near the constriction, permitting the escape of the intestinal contents, when a fecal smell tinges the putrid exhalations. The strangulated loop of intestine, or omentum, is dull-looking, black, soft to the touch and easily torn, flabby, œdematous, and often spotted with flakes of lymph, or sloughs, or with patches of black ecchymosed blood, or of greenish or ash-colored spots of sphacelation, easily broken down. There is also œdema of the tissues in the neighborhood, and an emphysematous crispness around. The sac in these cases contains dark colored blood, or fetid serum, sometimes fecal in smell from extravasation of the intestinal contents.

General Diagnosis and Treatment of Strangulated Hernia.—The first duty of the surgeon in all cases where there are signs of obstruction or strangulation, is to examine carefully all the usual sites of abdominal rupture, and to continue his researches also, in case of not finding a cause, into the unusual positions of hernia.

In searching for the causes of symptoms of intestinal obstruction, it must not be forgotten that a hernial tumor may be found at one of the usual outlets, and that yet it may not be the cause of the obstruction. In such a case, reduction by the taxis, without relief of symptoms, will prove that the cause must be sought for elsewhere. If there be two or more hernial tumors, they must be in turn reduced, and the effect upon the symptoms observed. If one of them be irreducible, it will probably be the offender. If strangulated, it will be tense and tender, and the pain will be more or less referred to it. In all cases of multiple hernia, with symptoms of strangulation or obstruction, the irreducible hernia must be the first chosen for operation; and if all are irreducible, the one which is hardest, most tense and tender, to which pain is most referred, or which came the earliest. Again, a tumor, which yet is not a hernia, may exist at one of the hernial openings, and may coexist with symptoms of intestinal disturbance, nausea, vomiting, and constipation. In the scrotum and region of *inguinal hernia*, such a tumor may be a cyst connected with the cord; a fatty tumor; a sarcocele, complicated with thickening of the cord; a large hydrocele of the tunica vaginalis; a hæmatocele; a varicocele; or a pelvic abscess. In that of *crural hernia*, the tumor may be an enlarged, and, perhaps, inflamed gland; and this last is, from the local pain and tenderness, and from the constipation and sickness frequently coexistent, the most perplexing to the surgeon. Or here we may have also a cyst, an abscess (psoas), a fatty tumor, or a varicose enlargement of the femoral or saphena vein, or one of their branches. In cases of other varieties of hernia, especially in the *umbilical*, a fatty tumor or an abscess may simulate hernia by its impulse on coughing, or by its general appearance and feel. A sarcomatous, or other tumor may also present some appearance of rupture.

Measures of relief should be adopted without loss of time. When a rupture is found, the indications are to return the strangulated parts into the abdomen by manipulation, if possible, aided by other secondary measures. If this is not successful after a fair trial, then the tumor must be operated on. Moreover, in cases in which the peculiarity of the symptoms leads to a strong doubt as to the nature of a tumor, an exploratory operation under the spray should be resorted to, to make quite certain that the patient either can or cannot be saved.

The term *taxis* is a Greek word applied to the proceedings of manipulation. The taxis should be employed with the least force and the greatest gentleness possible: much damage may be done by misdirected, hurried, or violent efforts. It should be gentle, but firm and persistent. If the rupture be large enough, the fundus of the tumor should be grasped by one hand and gently squeezed, to press out the blood from the engorged vessels, any serum which may be in the sac, and the fluid or gaseous contents of the bowel which may be present. The finger and thumb of the other hand should then be applied to the neck of the sac, and kneaded gently all around with the object of returning those parts which lie in the orifice, and which were the last to come down. If the rupture be small, the points of the fingers only can be used, and the skill to use these successfully lies in a combination of grasping, pressing, and kneading motions, which can only be acquired by long experience. The direction of the force applied should be that of the protrusion above the most superficial hernial opening, and varies with the kind of hernia, as will be seen in considering the anatomical details of the various special kinds of rupture.

The first hopeful result is usually a diminution in the total size of the tumor, a feeling of motion in the interior, and a slight gurgling croak, indicating the movement of the contained gases if bowel be present. The kneading motion and the compressing force must then be kept steadily applied, and the rupture-tumor, if containing bowel, will usually suddenly disappear into the abdomen. If omentum be present in any amount, its complete reduction is somewhat slower and more gradual, and there may be a little difficulty in passing up the whole of it if it be lumpy. Or a portion may be adherent and irreducible, although the return of the more vital intestine may have placed the patient in safety. The position of the patient during the taxis should be recumbent, with the shoulders low, the hips raised, and the knees bent up to the body and as close together as may be convenient to the operator, who stands on the affected side of the patient, with one hand and arm between his knees in cases of inguinal and femoral, or obturator rupture.

In cases of difficulty, the patient should be placed during the continuance of the taxis, more or less in an *inverted position*. This is best and most quickly accomplished by drawing the patient, with the upper part of the mattress, bed, and bedding, off the side of the bedstead, and placing them on a low stool or upon the floor, keeping the patient's hips on the side of the bedstead with the knees still drawn up. The effect upon the bowel and omentum is to allow them to gravitate towards the diaphragm and away from the hernial point, and thus to draw the hernial contents into the abdominal cavity. This action may be aided considerably by an assistant pressing gently with his hand on the abdomen near the rupture, sliding it slowly in a direction from the strangulated part, while the patient makes a long and deep expiration and slowly repeats it. Baron Seutin stated that he could sometimes relieve strangulation by insinuating the point of a finger into the tightened opening and stretching the constriction, but common sense and experience tell us that when the point of a finger can be introduced from without, there cannot be much strangulation present, and that if there were much, such a forcing in of the finger could not but be disastrous to the distended, tense, and softened tissues, and might easily burst the bowel.

The most powerful auxiliary to the taxis is undoubtedly the influence of anæsthetics, and of these, chloroform, from its greater influence in paralyzing the muscles without much previous spasmodic contraction, is better than ether alone. The best of all is a mixture of chloroform, ether, and alcohol, one part of the last with two of the first, and three of the second. An anæsthetic should, in all cases in which there is no serious objection to its use, be employed as soon as it is found that the rupture does not return by the simple taxis. All other so-called auxiliaries, such as hot baths and fomentations, blood-letting, antimony, opiates, and enemata, especially those of tobacco or other active drugs formerly employed, cause dangerous delay or injurious hindrance. In cases of the less acute kind, however, such as of large herniæ which have become infarcted, where the symptoms are not acute and point rather to obstruction than strangulation, the application of ice-bags to the tumor for a few hours, with the administration of enemata through a long rectal tube, to remove flatus, etc., sometimes aid the taxis to a successful issue. Ice, as a rule, however, should not be applied to small crural herniæ occurring in aged women with thin tegumentary coverings. In such cases it may, if kept long on the congested bowel, produce mortification. Such cases, if the taxis fails, call imperatively for operative procedure within forty-eight hours of the time of strangulation.

If much force is used improperly in the taxis, the tumor may sometimes be made to disappear into the abdominal wall without release of the strangulation. This is called *reduction* "*en bloc*" or "*en masse.*" It most readily occurs when the strangulation is effected by the neck of the peritoneal sac itself, either from inflammatory thickening, with internal bands or adhesions, or from external bands in the closely investing "fascia transversalis." By a disproportionate exercise of the pressing over the kneading process, the sac with its strangulated contents is pushed into the loose sub-peritoneal tissues, or between the abdominal muscles and fascia on one side of the hernial canal, tearing asunder the tissues to make a lodgment for the sac. In some instances, the sac has been found burst near its neck by the force applied, and the contents forced through the torn aperture into the connective tissue between the layers of muscles and fascia, or under the peritoneum. Here the sac is often found filled with blood, and there is extravasation in the areolar tissue and sometimes within the peritoneum. In such cases the symptoms of strangulation of course continue, and in an aggravated degree, especially the pain and tenderness at the part; the collapse is more marked; and a close manual examination of the hernial canal will reveal the presence of the hidden tumor, deep down, close to the abdominal cavity. Under these conditions the only rational remedy is immediate exploration by operation. This proceeding requires much care, since the anatomical relations of the parts are greatly altered, and the tissues may be torn, bruised, ecchymosed, and matted together by adhesions. The sac, or even the bowel, may be found burst by the force used. In all operative proceedings of this nature, the antiseptic method should be carefully observed so as to diminish the effects of the subsequent exposure to air.

INGUINAL HERNIA.

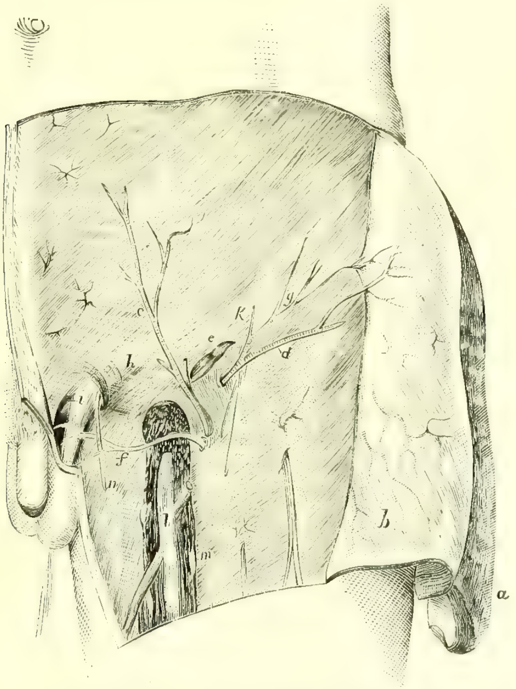
We now proceed to consider in detail the special forms of hernia, commencing with the most common, viz., Inguinal Hernia.

FREQUENCY OF INGUINAL HERNIA.—Out of 93,355 cases, in the statistics collected by Bryant, there were 7 inguinal to 1 femoral. In upwards of 3000 cases seen by myself, the proportion of inguinal hernia has been rather more than this, viz., about 8 inguinal to 1 femoral. In a considerable number of cases a rupture is more or less developed on both sides, double crural hernia being rather more frequent than double inguinal. Often the rupture is crural on one side and inguinal on the other, and occasionally three ruptures have been present, an umbilical one in addition to the other two varieties. This last condition has been most commonly seen in infants, occasionally associated with undescended testis, and all resulting from slowness or arrest of development in the parts. Hernia is more common in males than in females in about the proportion of 4 to 1. In the male sex the inguinal variety is more frequently found than in the female. In the former the proportion of the inguinal form of hernia to the crural is at the rate of 50 to 1. Inguinal hernia is found more frequently on the right side of the body than on the left side, in the proportion of about 3 to 2. In about twenty-five per cent. of cases it is found on both sides. The greater frequency on the right side is due mainly to the lower position of the root-attachment of the mesentery on that side, and to the pressure of the liver above. Something may be due also to the more frequent use and stronger muscles of the right arm and leg.

PARTS INVOLVED IN INGUINAL HERNIA.—These are situated in the groin just above the groove which indicates Poupart's ligament, which is a strong band of tendinous fibres forming part of the insertion of the tendon of the external oblique, and reaching from the anterior superior spine of the ilium to the spine of the pubis. On removing the skin and the two layers of superficial fascia, it is seen (Fig. 1126) that two small vessels pass upwards and inwards from the common femoral, and cross Poupart's ligament and the inguinal canal. They are the *superficial epigastric* and the *superficial external pudic*, the first lying external, almost over the position of the deep ring, and the last internally placed, and crossing the cord near the superficial ring; crossing in the same direction inwards, below this, is another branch, the *deep external pudic* artery. The deeper layer of superficial fascia is attached loosely to Poupart's ligament, and is continuous with the deeper layer of perineal fascia continued over the spermatic cord. The nerves are branches of the *ilio-inguinal* and *ilio-hypogastric*, offsets of the lumbar plexus, the former (*n*) emerging from the superficial ring (at *i*). The lymphatics pass downwards to the superior inguinal glands (*c*), which are arranged between the two layers of fascia on a line parallel to and above Poupart's ligament, and join the femoral or crural glands placed directly below them.

Then is exposed the aponeurosis of the external oblique muscle of the abdomen, commencing at the termination of its muscular belly, near the anterior superior iliac spine, passing downwards and inwards, obliquely, in flat bands of fibres, to be inserted externally into the pubic spine as *Poupart's* *ligament*, and internally into the front surface of the pubic angle and symphysis, sending some fibres to join the ligamentum suspensorium penis vel clitoridis. These bands are separated from each other a little below the centre of Poupart's ligament, where they form what are called the *internal and external pillars* of the external abdominal ring. The inner one is flat and ribbon-shaped; the outer, triangular, rounded below and grooved above, for the lodgment of the spermatic cord. They afford an opening for the passage of the spermatic cord or round ligament, the opening being placed directly above the pubic spine, and being obliquely triangular in shape, with its base downwards and its angle upwards and outwards. It is closed in by a band of fibres (*b*) lying superficial and closely adherent to the tendon, springing from the centre of Poupart's ligament, and curving spreadingly downwards and inwards, so as to cover by a connecting layer of tough fascia the fibres of the tendon and its triangular opening or ring. These fibres are continued downwards (*i*) as one of the coverings of the cord to join the scrotal fascia. They convert the triangular opening into an irregularly oval or circular one.

Fig. 1126.



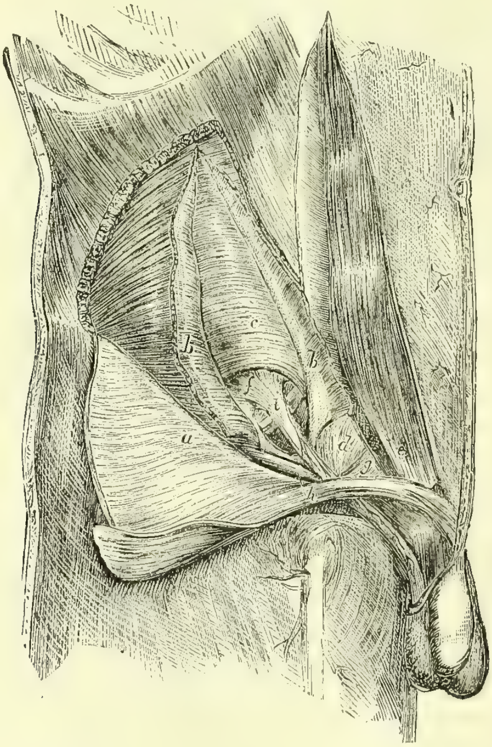
Superficial dissection of the inguinal and crural regions.

The opening thus formed is the *superficial* or *external abdominal ring*. Of the fibrous bands or pillars of the ring which bound the opening laterally, the inner is placed above, and the outer below the opening, in an oblique direction. The curved bands of fibres which bind these together and form the upper boundary, are the *arciform fibres* (*b*); the fascia between the pillars is the *intercolumnar fascia*; and the prolonged fascia over the cords is the *external spermatic fascia* (*i*).

Internal to the ring, and extending quite behind it at the lower part, can be seen the outer border of the rectus abdominis muscle, lying behind the aponeurotic sheath derived from the conjoined tendons of the internal oblique and transversalis muscles, blended here, also, to a considerable extent, with the tendinous fibres of the external oblique muscles. Some fibres reach across the linea alba, from the opposite side, are placed obliquely across the lower part of the superficial ring, and are attached to the crest of the pubis as far as the pubic spine, fortifying at this place the hinder wall of the inguinal canal. These are known as the *triangular fascia.* (See Fig. 1127 *g.*) On turning aside the oblique aponeurosis (*a*), the lower muscular fibres of origin of the internal oblique (*b*) are seen arising from Poupart's ligament as far down as the inner third, covering and fortifying the upper part of the front wall of the inguinal canal and the deep ring (*f*).

The muscular fibres of origin are continued along the lower third of Poupart's ligament as the *cremaster muscle*, the scattered fibres of which, connected by the cremasteric fascia, pass through the superficial ring—some, the outer ones, to be lost on the tunica vaginalis testis; the middle ones passing up so as to form loops, to become inserted into the fascia near the superficial ring; while some pass again into the ring to become implanted upon the conjoined tendon and triangular fascia. Thus is constituted in the perfect specimen the *cremasteric fascia*, recognizable to the surgeon by its muscular fibres, but very frequently feeble and indistinct in cases of congenital hernia. On dividing longitudinally the fibres of the internal oblique, it will be seen that they are deeply more or less blended with those of the transversalis

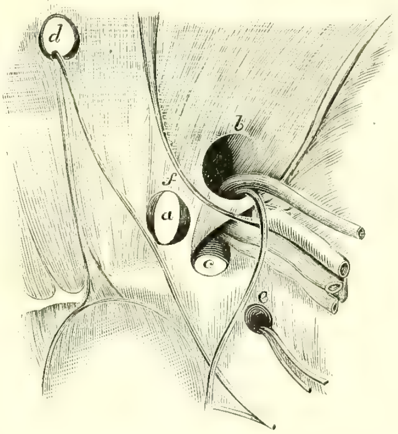
Fig. 1127.



Deep dissection of the inguinal canal and abdominal wall.

abdominis, arising from the upper third of Poupart's ligament, closely skirting the upper part of the deep ring, and separated externally by a thin fascia with the small hypogastric nerves, and with the communicating branches of the deep circumflex iliac and epigastric arteries. Internally, the two muscles become implanted upon a common tendon, the fibres of the transversalis occupying the outer border, while those of the internal oblique are implanted upon its surface. This *conjoined tendon* (*d*) covers the origin of the rectus muscle, but is continued beyond its outer border in a downward and outward direction to become inserted into the spine and pectineal line of the pubis, where it blends with the triangular fascia and Gimbernat's ligament, at the margin of the crural ring; and it is loosely attached by its deep surface to the *transversalis fascia* (*f*), which covers the deep surface of the muscle of that name, and separates it from the sub-peritoneal adipose tissue. If the finger be now pushed behind the internal oblique and transversalis muscular fibres, it will be seen to raise the conjoined tendon (*d*) as an oblique border, which can be felt by the finger curving behind the cord to form the lower two-thirds of the hinder wall of the inguinal canal. On dividing the muscular fibres of the transversalis, the arrangement of the fascia prolonged over the deep ring and spermatic cord is exposed to view.

Fig. 1128.



The internal abdominal ring.

The best view of the *deep* or *internal ring* is to be had from within, by making a transverse incision along the fascia above the centre of Poupart's ligament, and a longitudinal one to join it at the margin of the rectus muscle. Then, on lifting it from its deeper connections, the deep ring will be seen to form an oval opening (see Fig. 1128 *b*), about half or three-quarters of an inch above and a little internal to the centre of Poupart's ligament. The opening has its long diameter directed upwards and inwards, with the inner edge sharp and prominent, and it gives off from its borders a sleeve-like prolongation over the spermatic cord, called the *fascia infundibuliformis*, *fascia propria*, or *fascia spermatica interna*. The fascia is continuous with the fascia transversalis, as the sleeve of a coat with its body, and it narrows downward in a funnel-like manner. The vas deferens turns round its lower edge on its way to the pelvis, crossing the iliac vessels, while the spermatic nerves and vessels pursue a backward, upward, and inward course. There is thus a somewhat loose interval formed on the inner side of this sleeve-hole, which permits of dilatation under the pressure of a protruding bowel or omentum. And when a rupture is formed, the tightened fascia becomes thickened and stretched, and forms the most common seat of strangulation, either outside of, or in combination with, the sac. Below this, the sac is usually loosely connected with the fascia by adipose tissue. On the inner side of the deep ring, usually placed within a quarter of an inch, the *deep epigastric artery* (Fig. 1127 *f*) ascends inwards towards the umbilicus, to enter the sheath of the rectus, lying in the loose subperitoneal tissue. It is a vessel of considerable size, with a vein on each side of it, and at this point gives off a branch to the cord—the cremasteric—which lies in the cremasteric fibres, supplying them, and anastomosing with the spermatic and pudic arteries. It arises from the external iliac, just above the crural and below the deep inguinal opening. It is subject to some irregularities which will be mentioned in relation to crural hernia. Crossing the posterior inguinal wall, upwards and inwards to the navel (see Fig. 1128 *d*), internal to this, and lying behind the border of the conjoined tendon, is the obliterated *hypogastric cord*, the remains of the fœtal placental artery. It gives off before its point of obliteration the superior vesical artery to the bladder. Internal to it passes out an inguinal rupture, when it assumes the direct form, emerging between this obliterated artery and the outer edge of the rectus muscle, which form the two sides of the *triangle of Hesselbach*, the base being formed by the inner end of Poupart's ligament. The peritoneal investment behind this is loose and movable, and a direct rupture either passes through, or is covered by, a prolongation of the conjoined tendon, which is placed here, filling up the triangle. (See Fig. 1127.)

The *inguinal canal* is thus an oblique, valvular opening, in the layers of the muscles and fascia placed above the inner half of Poupart's ligament, its anterior wall being composed of the integuments, aponeurosis of the external oblique, intercolumnar fibres, lower fibres of internal oblique, and cremasteric muscle. It is from one to two inches long, and half an inch wide—wider in the male than the female, but longer in the female.

The *spermatic cord*, consisting of the vas deferens, with its artery, and the spermatic vessels and nerves, loosely connected together by an areolar investment, traverses the oblique inguinal canal in a direction more directly upwards than that of the canal itself. Thus it is separated above from Poupart's ligament by an interval of from half to three-quarters of an inch, where a groove can be felt with the finger, formed by the junction of the fascia transversalis with the deep surface of the ligament. This groove it is important to recognize in operating for the radical cure of the oblique kind of hernia. At the lower end of the canal, at the superficial ring, the cord crosses obliquely the insertion of Poupart's ligament, grooving it deeply just outside the pubic spine, which thus acquires an important internal relation to the cord. Lying upon the cord, under cover of the cremaster muscle and its fascia, is the genital branch of the anterior crural nerve, sending off its filaments to the loops of the cremaster muscle, and, finally emerging from the superficial ring to supply the dartos scroti, and so communicate with the perineal branches of the internal pudic nerve.

COVERINGS OF INGUINAL HERNIA.—An *oblique* or *external* hernia (so-called because it passes outside of the epigastric artery), traverses the deep ring and inguinal canal, and is covered by the structures forming the anterior wall of the canal, viz., the integuments, the aponeurosis of the external oblique, with its arciform or intercolumnar fibres (fascia spermatica externa), by the lower fibres of the internal oblique and the cremasteric fibres and fascia, and by the infundibular prolongation of the fascia transversalis or fascia propria. Then comes the peritoneal sac, covered by adipose tissue separating the contents of the rupture from the constituents of the cord and their investing areolar tissue. The hernia lies on the hinder wall of the canal, this consisting of the triangular fascia, the conjoined tendon, and the fascia transversalis, covering the epigastric vessels and hypogastric cord.

A *direct* or *internal* hernia is wanting in the covering of the infundibuliform fascia, and may have an investing layer from the conjoined tendon and fascia transversalis, and sometimes from the cremasteric fascia.

In a case of inguinal hernia of long standing, and originally and essentially an oblique or external hernia, where the neck of the sac is wide and large, the epigastric vessels may be dragged inwards by the weight and traction of the hernia, and may closely invest the lower and inner, and sometimes a portion of the upper part of the circumference of the peritoneal opening. In such cases, the rupture will assume the appearance of a direct hernia, and the edge of the rectus muscle may be felt to form the inner margin of the deep opening of the sac. The inguinal canal will be very short, and the two openings almost directly opposite to one another, as in internal or direct hernia.

The most common seat of strangulation in an oblique inguinal hernia, is at the inner edge of the fascial opening of the deep ring, thickened it may be into bands, or adherent to the neck of the sac. Or in old ruptures the strangulation may be placed in the thickened neck of the sac itself, or in adhesions placed entirely within the sac. In some large cases the stricture may be from muscular spasm of the internal oblique, and lastly, and most rarely, at the margins of the fascia or pillars of the superficial ring. The two last forms are usually most amenable to the use of the taxis. The most common seat of strangulation in a direct hernia, is the opening in the triangle of Hesselbach, where the fibres of the conjoined tendon encircle the neck of the sac, or, as in oblique hernia, in the neck of the sac itself, or in its contents.

An oblique hernia mostly depends upon some deficiency in the development and arrangement of the parts concerned in the descent of the testicle, which causes them to yield at an early or later period of life, and more or less quickly, to the internal pressure. A direct hernia is most frequently produced in muscular men by tearing of the tissues by violent efforts in lifting, etc. To the latter cases, the term rupture is more appropriate than to the former.

A hernia of either kind, when it has forced its way through the deep opening into the canal, lifting forward the front wall and bulging backward the hinder wall, and while it is protruding between the pillars of the superficial ring and dilating its inclosing fascia, is called a *bubonocele*, the name signifying a tumor or rupture of the groin. It is for a short time often arrested in its downward course into the scrotum by the contraction at the upper part of the latter, which indicates the commencement of the dartos muscle, where the loose adipose tissue ceases. And this may form, after complete descent, a sort of oblique, hour-glass contraction, which is also seen in cases of large hydrocele, making their way upwards in the opposite direction.

Descent of the Testicle.—This gland, originally developed from the Wolffian body below the kidney, as an abdominal organ, makes its way downward between the seventh and eighth months of intra-uterine existence. To effect its descent, a cylindrical mass of unstriped muscular fibre, the gubernaculum testis, developed and blended with the dartos scroti, and connected with the bottom of the scrotum below and with the peritoneum and lower part of the epididymis above, is aided by a portion of the cremasteric fibres to draw down the testicle till it reaches the middle of the canal, where those fibres are attached. The farther downward movement is accomplished by the gubernaculum and dartos alone, while the fibres of the cremaster, according to Mr. Curling, become invested with it, forming the invested loops characteristic of that muscle. The sac of peritoneum, which is destined in the male to form the tunica vaginalis, precedes the testicle, and is sometimes found in the female, reaching with the round ligament into the labium, which represents the corresponding half of the scrotum. This is the *canal of Nuck*, the most usual cause of oblique inguinal hernia in the female. Now, sometimes, by the occurrence of peritonitis in the fœtus during its intra-uterine existence, adhesions form between the testicle and the bowel, omentum, or iliac wall of the abdomen, or with the kidney itself, causing arrest of development, and, if these adhesions be strong and extensive, detention of the testicle within the abdominal cavity. If the adhesions are capable of elongation, the force of the gubernacular traction is sufficient to allow the testicle to reach into the inguinal canal, or to the top of the scrotum, immediately outside of the superficial ring. Sometimes this force is sufficient to draw down the sac of peritoneum, and even the epididymis (which may become unravelled and elongated), while the testicle itself remains within the abdominal cavity, or in the canal. We may then have one of those troublesome forms of hernia which are complicated with non-descent of the testicle. In all these cases, there is usually a deficiency of development in the cremaster and gubernaculum, as well as in the lower fibres of the internal oblique muscle, leaving a characteristic bulging of the groin. The scrotum and dartos also participate in the deficiency, and on the affected side, or on both sides of these structures, are shrunken and undeveloped. The testicle should be found in the fœtal scrotum in the last month of intra-uterine life, and of course at birth, and it is one of the duties of the accoucheur to observe if this condition be fulfilled, since the first cries and struggles of the infant tend powerfully to force down the thin intestines along the unclosed and unprotected canal of Nuck. Thus we have formed *a congenital hernia* (Fig. 1129), the sac of which is formed by the tunica vaginalis itself, or its representative sac of peritoneum. In this form, the bowel descends into the scrotum so as to touch and pass in front of the testicle, or even below its level, so that the gland is obscured as in common hydrocele. This variety of hernia is usually easily reducible, leaving the testicle distinct and evident to the touch.

The canal of Nuck, or channel of communication between the tunica vaginalis and the peritoneum, becomes closed, first at the deep ring, leaving a cicatrix which is always more or less traceable. The obliteration extends down the cord to within half an inch of the testicle. The serous membrane degenerates and is transformed into connective tissue, which more firmly binds together the elements of the cord. Sometimes the obliteration extends only to the parts near the deep ring. Then, while the cicatrix

Fig. 1129.

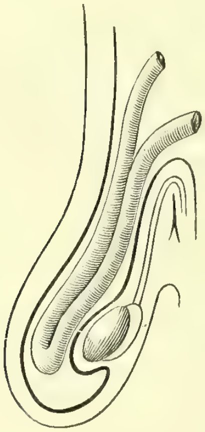


Diagram of congenital hernia.

Fig. 1130.

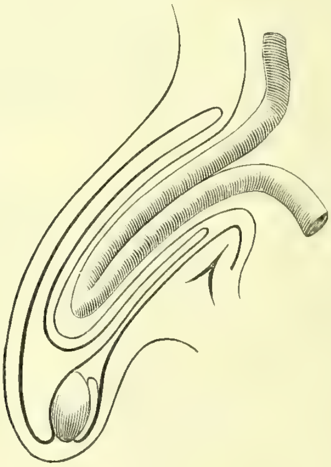


Diagram of infantile [or encysted] hernia.

is still weak, some violent crying or coughing efforts of the child protrude the bowel, pushing and dilating the cicatrix before it, and a fresh sac of peritoneum is invaginated from above into the upper part of the large tunica vaginalis, which is pushed before it into the scrotum. We have thus formed that kind of children's rupture with a doubled sac which is called *infantile* [*or encysted*] *hernia.* (Fig. 1130.) In this there are three layers of serous membrane placed in front of the bowel in the scrotum, viz., two layers of the invaginated tunica vaginalis, and one of the fresh, or real sac of the hernia. This may, like other forms of rupture, become strangulated, and may cause perplexity to the operator. Here also the testicle may be covered and obscured by the hernial protrusion, which is usually less easily reducible than in the strictly congenital form, when not complicated by adhesions within the sac.

The direction of the long axis of all forms of oblique inguinal hernia is obliquely upwards, outwards, and slightly backwards, and this must be carefully borne in mind both in diagnosis and in the application of the taxis. In direct inguinal hernia the long axis corresponds more to the axis of the body, with a more decided backward tendency at the neck of the sac. This backward direction is scarcely ever needed, however, in the manipulation of the taxis, as when the strangulated part moves under the pressure of the upper fingers, the contents slip inwards spontaneously. The application of the taxis in inguinal hernia, in infants and little children, especially when they cry violently, is powerfully aided by lifting up the pelvis from the bed by grasping the heels with the feet a little separated. This takes off the abdominal pressure in the violent, expiratory, crying and coughing efforts, and does no harm whatever to the child, if the shoulders and head be left resting on the bed. A slight shake of the body in this position aids also the pressure of the fingers, by the inward drag upon the engaged bowel and omentum.

Diagnosis of Strangulated Inguinal Hernia.—Inguinal hernia in a state of strangulation is usually easy to detect, by the association of a tumor in the region of the groin with general and abdominal symptoms of obstruction and strangulation. It is of practical importance to know, however, before proceeding to the taxis or to operative measures, first, whether the hernia is inguinal or crural, and secondly, whether, if inguinal, it be oblique or direct. In very stout persons, especially in females, this is sometimes by no means easy. The fold of skin in the groin is deflected downwards in fat persons, so that the long axis of the hernia may seem higher in crural, or lower in inguinal rupture, than it is in reality. The first means of diagnosis, and the most important, is by observing the relative position of the pubic spine and of the attachment of the inner end of Poupart's ligament. This can usually be made out even in the fattest subject. Then, if the tumor be felt to lie upon the pubic spine with its central axis above and internal to Poupart's ligament, while the opening of the external ring is blocked by the tumor, and the saphenous opening is free, we may be sure that the hernia is *inguinal*, and, if the reverse, that it is *crural*. The long axis of both of these herniæ, when fully formed, is downwards and inwards, but the inguinal is relatively higher and more internal. In *oblique* inguinal hernia, the neck-tumor is more pyriform, and extends more upwards and outwards along and above Poupart's ligament than in the direct variety, producing more obscuration of Poupart's ligament and of the spermatic cord, which may be felt to disappear behind it. In the *direct* form, the root or neck of the tumor, which is globular, seems to spring out of the abdomen immediately and suddenly above the pubic spine, the fulness not being traceable along the canal, but closely skirting the outer border of the rectus muscle. In old and large cases of oblique hernia, however, the structures internal to the neck of the sac are so dragged inwards by its pressure, that the latter is placed close to the rectus muscle, with the epigastric artery winding round its inner side, and it is often impossible to distinguish the two forms until incisions have been made in operation. In all, however, the direction given to the taxis should be in the line of axis of the tumor—upwards, outwards, and backwards—the latter direction earlier in the direct form than the oblique. In dividing the stricture at the deep ring, in operations in doubtful cases, the incision should be made directly upwards.

Operation for Strangulated Inguinal Hernia.—After failure of a full trial of the taxis, and the symptoms of strangulation continuing unabated, the patient should be moved to the operating table, and an anæsthetic administered, and a final effort with the taxis and inversion then tried. Frequently, when the anæsthetic has full influence, the rupture will pass up. If it does not, the parts should be shaved after anointing them with carbolized oil, and washed with a 1–20 solution of carbolic acid, taking care to thoroughly cleanse the pubis, penis, and scrotum. If possible, the carbolic spray should be used. An incision is then made through the integuments along the axis of the tumor, from the site of the deep ring to the fundus. One or two arterial branches, the deep and superficial external pudic, may require small catgut ligatures; then the inter-columnar fascia and arciform fibres are divided to the same extent, when the muscular fibres of the cremaster are brought into view. A director may now be used to divide these and the internal spermatic or infundibuliform fascia. Now the yellowish streaks of adipose tissue which indicate the sub-serous fascia, will be seen lying upon the grayish-blue sac. A pinch with the forceps will raise this about the centre, and the scalpel applied horizontally will open the sac, which must then be slit up upon the finger or straight director as far as the neck. Now the contents of the sac may be carefully examined and turned over. The forefinger, passed upwards to the strangulated point, will feel the inner edge of the deep ring, or the opening in the conjoined tendon (according as the case is an oblique or a direct one). The point of the curved, deeply-grooved hernia-director is now carried along the finger and insinuated between the sac and the bowel, and the hernia knife passed along the groove, with its edge directed upwards. If the case be clearly one of direct hernia, an inward direction may be given to the cut in order to avoid the epigastric artery. If an oblique hernia, an outward direction should be given for the same end. If the case be doubtful (as it may be), a directly upward and forward cut is the safest. The cut should be limited to the actually constricting fibres, and, if necessary, further room can be got by dilatation with the director or the finger.

The omentum, if present, should now be drawn down so as to permit a careful examination of the constricted portions. If it be found sphacelated, as may be known by its having a dull, dark appearance, and by its fetid smell, it should be cut off with a pair of blunt scissors, and all the bleeding twigs tied with thin catgut. The loop of bowel should then be drawn down for an inch and examined on all sides. If the bowel look healthy, retaining its glistening surface look, and if no ulceration be found at the constricted portion, although it may be congested and chocolate-colored, it should be carefully returned into the abdominal cavity after the omentum, which should be put up first. The edges of the wound are then brought together with sutures, sufficiently close, a drainage-tube being placed along the bottom and out at the lower end of the wound, and the parts dressed and well padded with carbolized gauze, tow, or cotton-wool, the whole secured with a spica bandage and a support to the scrotum. The patient is then put to bed, with the shoulders raised and a bolster put under the knees. Opium should be given to allay pain and maintain rest; milk and beef-tea, iced, to allay any remaining sickness or retching; milk-diet, and no stimulants, unless the patient show signs of sinking. The bowels may be left to themselves for four or five days, purgatives in any shape being contra-indicated. After this, mild enemata with olive oil may be administered, if required. If the gut be sphacelated and black, and have lost its lustre, with gray or ash-colored spots and a putrescent smell and foul secretion in the sac, the parts should be well washed with the spray; the bowel should then be opened longitudinally at the sphacelated part with scissors, and the sides of the opened bowel stitched to the skin by three or four points of suture. The spray may then be discontinued, and the wound dressed with lint soaked in 1–40 carbolic lotion, and covered by a large, loose lump of carbolized tow in the groin and perineum, held on lightly by a spica bandage. If the condition of the bowel be doubtful, the parts may be left *in situ* after free division of the stricture, and covered with lint dipped in warm water, the warmth being kept up by a hot-water sponge placed over all. The bowel may thus recover itself, and may slowly be drawn into the abdomen. It should be watched and examined twice daily, to see if the signs of mortification increase in certainty, and, if so, stitches should at once be placed on the bowel to prevent retraction into the abdomen and subsequent fatal extravasation. The bowel should be freely opened, and an artificial anus formed, as just described. The same expectant treatment should be followed in cases where a small aperture has ulcerated through the strangulated part, and permitted the escape of fecal matter into the sac. This should be first well washed out by carbolized sponges and the spray.

If the bowel be clearly ulcerated or sphacelated beyond recovery, it may, in favorable cases occurring in otherwise healthy individuals, be entirely removed by sections through the gut, including the diseased and damaged loop of bowel between them. The mesenteric attachment may then be divided, the arteries and veins tied with small catgut ligatures, the cut sections of the bowel brought together, and stitched round by a continuous or glover's suture, with small catgut, taking care to double inwards the serous edge so as to get the two serous surfaces in contact. It may then be returned into the abdominal cavity, after thorough cleansing with weak carbolic lotion, and the external wound closed with antiseptic dressing, with a drainage-tube passing into the abdomen at the lower angle of the wound. Patients treated in this way have occasionally made good recoveries.

If a portion of the omentum be thickened into a mass which cannot be returned, this should be removed, and all bleeding vessels tied with catgut ligatures cut off short. Any soft, recent adhesions of the bowel or omentum to each other, or to the sac, should be carefully separated by the fingers or forceps, and any oozing of small vessels staunched by pressure.

In favorable cases with little damage to the hernial contents, I have for many years been in the habit, at the end of the operation for relief of strangulation, both in inguinal and crural hernia, of taking away the sac after tying it with catgut, and closing the tendinous hernial opening by my wire operation, and with the best results, both without and with the spray and gauze treatment. A description of the modes of proceeding in these cases will be given presently.

DIAGNOSIS OF INGUINAL HERNIA WHEN NOT STRANGULATED.—When symptoms of strangulation or obstruction are absent, an inguinal bubonocele may be mistaken for *encysted hydrocele of the cord*. It may be easily distinguished, if the cyst be placed below the superficial ring, by feeling the canal and cord above the tumor, free from swelling and hernial impulse. If the cyst be within the canal, the diagnosis is more difficult. A cyst, however, is less changeable in size and position than a rupture; it is more tense, less compressible than hernia, whether omental or intestinal, and when it possesses a cough-impulse, it is not a dilating impulse, but a communicated one from above downwards. If not adherent, the hernia disappears when the patient lies down, and reappears on his standing up; whereas a cyst, although less prominent, is persistent in the recumbent posture.

A *scrotal* hernia may be mistaken, when irreducible, for a *hydrocele* or *hydro-sarcocele.* Its history aids the diagnosis; a hernia descends from above, and at first comes and goes with the change from the standing to the lying position, whereas a hydrocele begins below and grows upwards, reaching the inguinal canal by its pyriform prolongation only when very large, when it may be more easily detected by its translucency, fluctuation, and more heavy weight. It also more completely obscures the testicle to the sight and feel. A congenital scrotal rupture may also do this, if adherent, and if its contents are altered by inflammatory effusion, either solid or fluid, and it is in this latter condition that it is most likely to give rise to doubt, especially when some fluid effusion is present in the sac, or in the contained bowel. The condition of the cord at the superficial ring, and that of the inguinal canal, will help the surgeon to distinguish such perplexing cases. If the cord be free from swelling, and of normal size, and the canal undistended, the case cannot be one of hernia. In cases of sarcocele, or of malignant deposit in the testicle and cord, however, the cord in the canal may be thickened and hard, but its feel will be in these respects different from the large, soft, cylindrical swelling due to the presence of omentum or bowel. The history of the case and the other symptoms will generally make the diagnosis clear under such circumstances, and, if necessary, the use of a small aspirator-tube to draw off any fluid which may be present, may justifiably be had recourse to.

An elongated, irreducible, *omental* hernia may be hastily mistaken for a *varicocele*, or the two may coexist. The feel of the latter has been compared to the vermicular elasticity of a bag of live worms, while that of an omental hernia is doughy and lumpy, like that of a bag of dead worms. If reducible, the hernia, as well as the varicocele, disappears when the patient lies down. If then the finger be placed and kept on the cord at the superficial ring, and the patient be made to stand up, the omentum will be kept back, while the varicocele will slowly return and become even more distended than before. If the omentum be irreducible, it will not of course disappear on the assumption of the horizontal posture.

The rare cases of *diffused hydrocele of the spermatic cord*, extending along the unobliterated canal of Nuck, present more difficulties, especially in children, where this condition assumes the form of what is often called a windy rupture. It is prominent in the erect posture, and disappears by the passage of the fluid into the peritoneal cavity in the horizontal posture. When the patient stands up and coughs, there is an impulse closely resembling that of hernia. By the aid of a candle, however, the great and uniform translucency of the tumor, and also its distinct fluctuation, distinguish it from hernia, and drawing off the fluid by a small aspirating needle at once clears up any remaining doubt. If the fluid be in the sac of a congenital hernia, with an unobliterated vaginal process, the intestine or omentum will then descend and occupy a position in front of the testis.

The symptoms of *hæmatocele* resemble those of hydro-sarcocele, or hydrocele, except for the absence of translucency and, perhaps, of fluctuation, and for the presence of more pain, heat, and tenderness. Cases of acute hydrocele, after injury, may simulate scrotal hernia under similar conditions, and may require close observation and comparison of symptoms, and of the history of the case.

Fatty tumors growing from the sub-peritoneal or connective tissue of the cord may closely resemble irreducible omental herniæ. If they do not increase, they should not be meddled with further than by the use of a truss in doubtful cases, as pressure will be of service in either condition. If they grow and give trouble, they should be removed, whether omental or sub-peritoneal, with antiseptic precautions.

Chronic *pelvic* or *iliac abscesses* may point through the inguinal canal, guided by the vas deferens or round ligament, and may simulate, by the cough-impulse which they possess, the formation of a hernia. They are distinguished by the dulness of percussion in the iliac and inguinal regions, and by the fluctuation which is apparent when they protrude near the surface. The history of the case, and evidences of disease in the lumbar or pelvic region, will throw light upon their nature.

Hydatid tumors in the inguinal region or in the spermatic cord, may also simulate inguinal hernia. They are not reducible, are often lobulated, grow slowly but uniformly larger, and never diminish or alternate in size. An aspiration-puncture will most clearly show their nature.

Enlarged and *inflamed inguinal glands* may be attended with symptoms of disturbance of the alimentary canal, so as to simulate somewhat hernial conditions. When such glands are movable on their deep and superficial structures, they can usually be felt to be of the characteristic glandular shape, sometimes multiple, and distinct from the abdominal rings or inguinal canal. When inflamed, or suppurating, the irregularity of the lump, and the redness, œdema, and other appearances of induration, adhesion, fluctuation, etc., will be sufficiently clear, and further light may be gained from the presence of such affections of the scrotum and penis as give rise to sympathetic bubo.

Radical Cure of Inguinal Hernia.—The question of the propriety of employing methods for radically curing this troublesome and incapacitating condition of hernia, depends, first, upon the immediate risk to life of the steps proposed; and, secondly, upon the permanence of the cure thus produced. Of these considerations the first is by far the most important. It will be seen that the prudence of incurring immediate risk depends much upon the severity of the inconvenience, pain, and danger endured. Some of the principles of insurance here come into play. If the pain, inconvenience and loss, and ultimate risk be great, it will be right and prudent to risk more to remove them. The same may also be said of the prospects of certainty of success or failure in the remedy. Many remedies have been at various times proposed and tried. With but few exceptions these have been relinquished, because their results have been too fatal, or not efficacious in producing a permanent cure.

Space will not allow me here to consider the numerous and various ways in which a permanent cure has been sought for, from the earliest days of surgery to the present time. It will be sufficient to give those methods which my own experience has found to be most favorable for the desired end, and from the results of which we can most securely calculate the patient's chances. We can then judge of the advisability of recommending a patient to seek the advantage of a radical cure, or to be content to suffer the evil that he has.

In estimating the advisability of undertaking an operation for the radical cure of any hernia in which an operation is at all feasible, we must first consider the risks incident to the hernial condition. First, the risk to life. This amounts to the estimate usually made by the medical referee to a life-insurance company, as to the premium to be paid by a hernial patient. If we take 25 per cent. as the proportion of reducible hernial cases, which sooner or later become subject to strangulation or other consequences which immediately endanger the life of the patient, we shall certainly not at all over-estimate this risk. In irreducible hernia the chances of such a result are at least trebled. The risks of an operation for strangulated hernia are again much increased by the unfavorable conditions of general health, etc., under which the operation must usually be undertaken; and this again is further greatly increased when the hernia is irreducible. The risk of strangulation is vastly greater if the patient is placed in circumstances under which the necessity for bodily labor or great muscular exertion is constant and recurring; and its dangers are more serious if he is likely to be far from medical aid, and from opportunities of having efficient renewal and timely adaptation of trusses. Soldiers, sailors, travellers, colonists, sportsmen, and farmers in remote districts, far from medical advice and aid, all undergo greatly increased risks from strangulation. Death and physical disability in the struggle of life are in their cases more threatened than in the cases of those who live at home and at ease. The same may be said of strangulation occurring among strong and muscular men who are fond of, and otherwise best adapted to, athletic exercises and pursuits.

We have also to estimate the pain, trouble, and inconvenience arising from the difficulties of making proper and efficient truss-pressure, and its constant renewal; the danger resulting from blows or other external injuries; and the constant tendency of the rupture to grow larger and more unmanageable, or irreducible, and of truss-pressure to be less available, as the patient grows older and less able physically to endure the pain and danger of frequent strangulation.

Again, there are to be considered the care and expense involved in the constantly recurring necessity for new trusses, or for repairing the old, especially in remote countries and in tropical climates, where the conditions of existence render truss-renewals more frequently required, while the distance from instrument-makers renders them more expensive, tedious, and difficult.

In irritable natures, the worry of unsatisfactory truss-pressure removes the slender possibility of a cure by this means, and often renders life a burden, and deteriorates the constitution so as to predispose to tendencies which shorten life. The trouble and risk are of course directly increased if there be local complications, such as non-descent of the testicle, or the supervention of a hydrocele or varicocele, as not uncommonly occurs in advancing years. Urethral stricture or enlarged prostate, a chronic cough, or an enlarged liver or diseased kidneys, causing, accompanying, or supervening upon hernia, also multiply to a variable and indefinite extent the troubles which it produces, its chances of strangulation, and the risks of dealing with it if strangulation occurs.

It is, of course, difficult to give an exact estimate of the risk to life of the hernial condition as compared with that of the operation for its radical cure, but it is less so than that of estimating the pain, worry, suffering, and inconvenience of wearing trusses, generally more or less inefficient, and always liable to fail at the moment of greatest muscular effort, when their support is most urgently required.

The risks and advantages of a radical cure for hernia vary of course with the method adopted, and the conditions of the rupture under which it is undertaken. So much in this respect depends upon the tact, judgment, experience, and manipulative skill of the individual surgeon, that I can only base my comparison upon the results of my individual experience, which will be found in detail in a subsequent portion of this article. That an immense deal does depend upon such skill and experience, is shown in this, as in other operations, such as ovariotomy and laparotomy. In the history of those operations, as well as in that for the radical cure of hernia, it is distinctly shown that the mortality and failures of the earlier attempts of all surgeons are very much greater than when experience has brought the knowledge, care, and skill necessary to deal successfully with the conditions of each case. Much depends upon the choice of cases, but more upon the surgeon's manipulative skill, the plan of the operation, and the after-treatment adopted.

In the first hundred operations for the radical cure of hernia performed by myself, while trying various methods—such as plugs, ligature-threads, and compresses of various forms—and on all kinds of hernial cases in which success was at all likely to be obtained, the number of deaths was three. One of these was from pyæmia, and another from erysipelas—both dangers which the advance of antiseptic surgery has rendered so infrequent as to be practically abolished. The third was from peritonitis, which, as shown clearly by the post-mortem examination, was set up by other causes than the operation.

In the last two hundred cases operated on by my subcutaneous-wire method, not one has been attended by any serious or unpleasant symptom.

If all these cases are taken together, the risks of my various methods amount to one per cent. If the results of the perfected operation only are taken, the risk to life (as far as 200 cases go) is nothing. And this, I think, may be taken as the basis of calculation (allowing for the fallibility and imperfection of individual surgical skill), in healthy subjects below the age of 40, affected with reducible inguinal hernia.

The next most important consideration is the chance of failure in the production of a cure by operation.

This may be set against the trouble, pain, and irksomeness of wearing a truss without an operation. The difficulty of exactly ascertaining the percentage of failures, or of return of the rupture months or years after the operation, is great. The results which I have been able to ascertain satisfactorily, will be given hereafter.

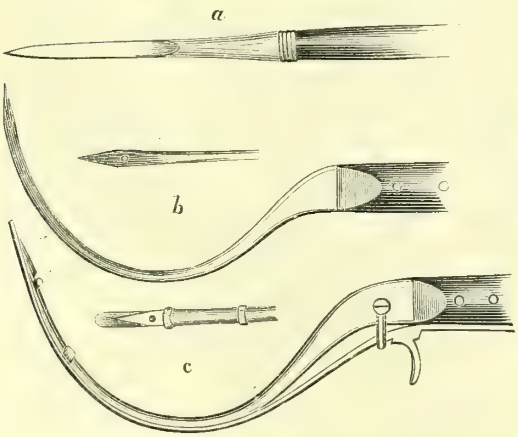
In this place, it is enough to say that in favorable cases I estimate the successful results of the subcutaneous wire operation at 75 or 80 per cent., and in less favorable cases at 60 per cent. And, what is a very important element in the calculation of chances, in a great many of the cases in which a certain amount of reproduction of the rupture has occurred, a truss has been made available and successful in keeping up the remaining protrusion, and in making the patient comfortable, when it was not so before the operation. In some cases also, the groin, though at first weak, has improved under the subsequent pressure so much, and the usual contents of the rupture have been so completely kept out of the sac, that a firm cure has subsequently and finally resulted.

Again, in not one of the cases operated on, as far as can be ascertained, has the patient's condition been rendered worse by the operation. And this also is a very important consideration.

In those cases in which a cure has resulted and endured for some years, and under extraordinary efforts or by accidental injury has again given way and reproduced the rupture, it must be considered that in the mean time the patient has had all the advantages of a sound groin, and has been relieved from the inconveniences of a truss. And the rupture in such cases must properly be considered as a fresh rupture, produced by the giving way of fresh parts of a groin originally weak, and produced by a force which might have, and often does have, the effect of causing another rupture in a different part of the abdomen, just as a fatty or other tumor, after being removed in one place, occurs in another from constitutional causes. No surgeon is thereby warranted in objecting to the removal of the original tumor, or even to a repetition of the operation, if necessary, although the mortality of such an operation may exceed that of the radical cure of hernia in reducible and favorable cases. The loss of time and the expenses attendant upon the radical cure of hernia are small in comparison to those of a life-long rupture, and can scarcely be seriously estimated. The mere money-value of the former must be greatly smaller than that of the latter, while the losses from disability for various callings, and from opportunities in life unavoidably neglected, must in many cases be very great. Again, when the radical cure is accomplished in early youth, when time is of little value and when the chances of success are correspondingly great, the risk amounts to nothing at all. Patients may thus be made strong and capable men and women, fitted for the wear and tear of labor and exertion, of pregnancy and parturition. Moreover, hernia can be with most certainty cured while it is yet small and manageable, and the cure by operation is more certain than that by the slow, tedious, and very uncertain treatment by truss-pressure, while it is certainly less irksome, painful, and inconvenient. Upon the principles of insurance, and in accordance with the maxims of prudence, the evils of a hernial condition are best counteracted, as a general rule, by an early recourse to the benefits of operative surgery in effecting a radical cure.

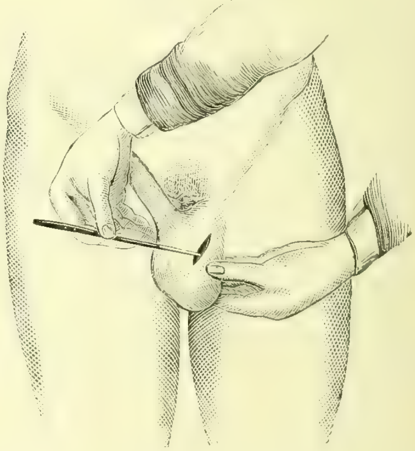
Operations for the Radical Cure of Inguinal Hernia: The Subcutaneous Wire Operation.—This operation I consider to be the best for cases of perfectly reducible hernia, and especially for those in healthy children and young persons, in whom truss-pressure has been found to make no progress towards closing up the aperture, and particularly if they are likely to be called upon for a life's work which will remove them far from instrumental and surgical assistance, or will render them incapable of meeting the necessary and recurring expenses, while at the same time it will test and try their physical powers of resistance. It is also applicable to those cases in which trusses fail in keeping up an increasing rupture, or cause, in some way or other, great discomfort to the wearer.

Fig. 1131.



Instruments required in operation for radical cure of inguinal hernia.

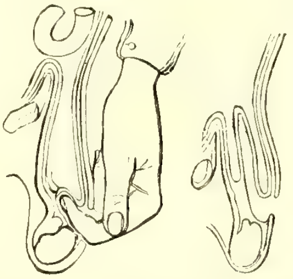
Fig. 1132.



The scrotal incision.

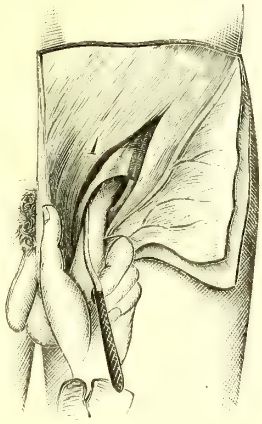
The patient being placed on the table, the parts shaved clean and purified, and an anæsthetic administered, so as to get the muscles relaxed, an oblique incision is made with a small, sharp-pointed tenotomy-knife, well washed in 1–20 carbolic lotion, in the front of the scrotum over the fundus of the rupture, three-quarters of an inch long, and through the skin and superficial fascia. (Fig. 1132.) The handle of the knife is then used to separate the integumentary tissues from the deeper fascial coverings of the hernia, or cord, so as to form a circle of detached integuments large enough to be invaginated into the hernial canal without drawing up the skin into the superficial ring. A stout handled needle (Fig. 1131), equally curved in the segment of a circle, with a sharp point, blunt shoulders, and a large eye near the point, is used for carrying the wire. This should be well-annealed and flexible copper wire, silvered over, thick enough not to cut the tissues when drawn tight, but not so thick as to be at all inflexible. A piece about twenty inches long, briskly rubbed so as to render it flexible and clean, dipped in a 1–20 solution of carbolic lotion, and then in carbolized oil (1–5), should have each end bent into a hook three-quarters of an inch long, and evenly curved so as easily to pass the eye of the needle. The fore-finger, oiled, should then be passed into the scrotal puncture (Fig. 1133), and made to invaginate the fascia and sac into the hernial canal, as far up as it will go into the deep ring behind the lower fibres of the internal oblique muscle, which should be raised well upon the finger. To the inner side of the finger will then be felt the raised edge of the conjoined tendon, lying on the outer side of the rectus abdominis muscle. The needle must now be carefully and slowly passed along the finger until its point can be felt plainly by the bulb of the digit placed behind the conjoined tendon. The point should next be directed inwards so as to take up the tendon, and to transfix it and the aponeurosis of the external ob-

Fig. 1133.



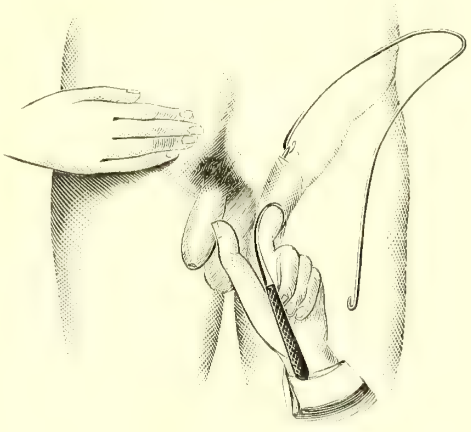
Invagination of the fascia by the fore-finger

Fig. 1134.



The needle perforating the conjoined tendon.

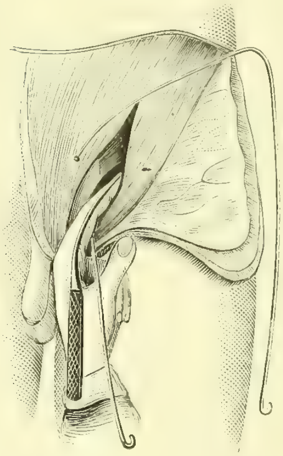
Fig. 1135.



Introduction of the wire.

lique which covers it. Its point will then be seen to raise the skin. The skin must next be drawn towards the median line, and the needle directed by its stout handle so as to bring its point out through the skin, one inch and a half external to the puncture, through the deeper tissues (Fig. 1134). One end of the wire is then hooked on to the eye of the needle, and is drawn with it by a slight jerk through the tissues emerging at the scrotal puncture. (Fig. 1135.) The needle is next detached from the wire, and the finger again passed into the canal. Now the spermatic cord is to be felt for, lying in a groove formed by the union of Poupart's ligament with the fascia transversalis. The cord is to be pushed gently inwards, and the point of the finger placed in the groove which it occupied, and lifted forwards, so as to elevate Poupart's ligament at its centre, and with it the outer pillar of the superficial ring.

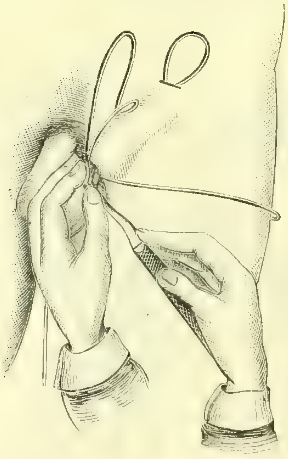
Fig. 1136.



The needle penetrating Poupart's ligament.

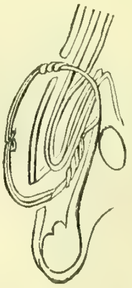
The iliac artery may be sometimes felt behind the finger, which lifts up the tendinous structure from its immediate contiguity, and protects the vessels from injury. The needle, passed again along the front of the finger, a little to its outer side, is then pushed through Poupart's ligament till its point raises the skin. (Fig. 1136.) The latter is now pulled inwards until the point of the needle can be made to pass through the same puncture in the skin of the groin which the wire already traverses. The opposite end of the wire is next hooked on to the needle, drawn down as before through the scrotal puncture, and then detached. There is now a wire-loop at the groin, and two hook-ends at the scrotal puncture. Opposite the latter, the sac is then pinched up by the finger and thumb, in the same way that a varicocele is separated from the spermatic duct when submitted to operation. An assistant seizes it with

Fig. 1137.



Needle crossing the sac.

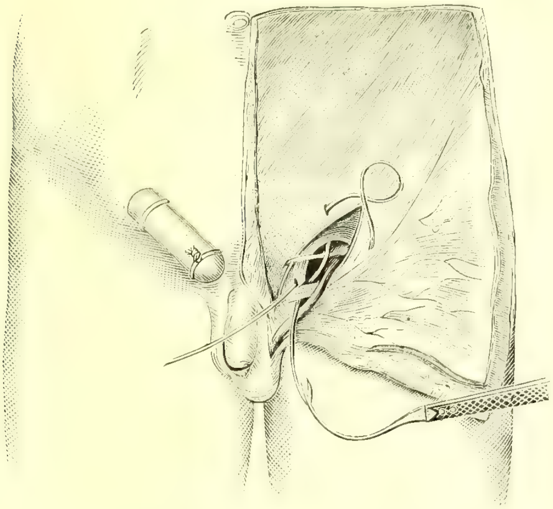
Fig. 1138.



The wire twisted and locked.

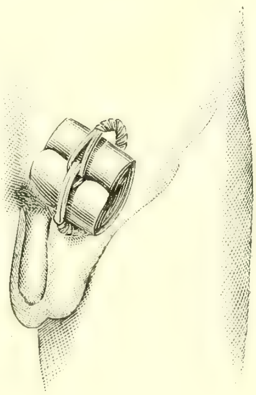
finger and thumb, also in the same way, at about two inches distance, both assistant and operator recognizing the situation of the spermatic duct. The needle is then passed at one corner of the scrotal puncture (Fig. 1137) across the sac, in front of the duct, and out at the other end of the scrotal puncture. The skin here is so elastic that the puncture stretches sufficiently to allow this to be easily done. The inner end of the wire—viz., that which traverses the conjoined tendon—is next hooked on to the eye of the needle and drawn across behind the sac. Care must here be taken, by dealing with the wire roundly, not to make an acute bend or kink, which would put a needless difficulty in the way of its subsequent withdrawal. The wire should be drawn down so as to get straight parts in the tissues, and to bring the loop an inch or so from the skin-surface. The two scrotal ends are then twisted twice or three times around each other, the operator observing the direction of the twist, so as to be able readily to untwist the wire when it is to be withdrawn. The loop of wire above is now seized and drawn firmly upwards, so as to invaginate the scrotal fascia into the hernial canal as high up as the deep hernial opening, and it is then twisted firmly down, in the same way and with the same precautions as the lower ends. The ends and loop are then bent over towards one another (Fig. 1138), the former cut off to a convenient length, passed through, and bent on to the latter. In very large cases, where the superficial ring is very patulous, the wires may be crossed in the canal, and the needle passed through the pillars near the pubis, after the sac is invaginated. Thus the lower opening of the hernial canal may be more effectively closed. (Fig. 1139.) In these cases a cylindrical pad of glass or boxwood may be used with advantage to secure the loop, and for the ends of the wire to be twisted over, as seen on the other side of the figure. A pad of lint, large enough to exercise compression, is fixed under the bight of the double wire loop which has been formed (Fig. 1140), a little carbolized tow is put over the scrotal puncture to catch any discharge, and a flannel spica bandage is applied, the ends of which, on being tied, should be made into a sling or suspender to support the whole of the scrotum and penis. The patient should be placed in bed, with the shoulders well raised and the knees tied

Fig. 1139.



Modified operation for very large herniæ.

Fig. 1140.



The compress in position.

together and bent over a long bolster, with a prop for the feet to keep the body firm. The bowels should be opened on the morning of the operation, and then left until some discomfort is experienced. Opium should be given for the first twelve hours—one grain every four hours—until pain ceases or sleep comes on. The diet should be of milk and beef-tea, with ice to relieve any nausea left by the anæsthetic. No stimulants are advisable. The pain usually passes off in twelve hours. The discharge is trifling and of a serous character. The bandage rarely requires to be touched till three days have elapsed, when it may be removed entirely, with the pad of lint. A lump of well-teased antiseptic tow placed under the wire will be sufficient dressing. The scrotum should be well supported. In a few cases the urine may require removal by a catheter, for the first day or two, on account of the patient's disinclination to contract the abdominal muscles.

The wire should be kept in for from eight to twelve days, according to the amount of reaction set up, the lower ends of the wire acting as an efficient drainage-conductor. At the end of this time the wire may be untwisted, and it will then be found that the two parallel, straight portions of the wire, which originally passed through different tracks, have by slow ulceration joined each other in the same track, and that they will come out together by cutting off their lower ends with pliers, and pulling upon the upper loop. If by reason of slight kinks there is any difficulty in this, the wire may be straightened by pulling at each end with pliers, and the ends may then be withdrawn together or singly. The upper opening usually closes soon after their withdrawal, and a truss may then be applied, with cotton-wool beneath it, and the patient may be allowed to get up and lie on a couch until the lower sinus heals.

Sometimes a little swelling of the testicle, or effusion into the tunica vaginalis, shows that the spermatic cord is closely embraced by the wire, but this rarely calls for any special treatment, being entirely removed by the wire's withdrawal. In only one case, in which a steel clamp was used to hold the ends of the wire instead of twisting them, has atrophy of the testicle followed the operation. I have met with no burrowing of matter since substituting the wire for the hempen ligature and compress. The straightened wires act as efficient and cleanly drainage-conductors, aided by the raised position of the shoulders and trunk.

Very little discharge is usually present throughout, and it only becomes purulent in the last few days. A large quantity of fibrinous effusion mats togther the walls of the canal with the inclosed, invaginated sac. The induration, however, soon disappears, and the cure depends not upon its plug-like formation, but upon the adhesion of the hinder wall of conjoined tendon (at *a*, Fig. 1141) with the front wall and Poupart's ligament, adherent to and embracing the cord. The effect of this operation, when successfully accomplished, is to unite in one cicatrix the sides of the inguinal canal as far up as the deep ring, together with the pillars of the superficial ring, the union of which supports the invaginated, twisted, and obliterated sac, with its intimate coverings of external and internal spermatic and cremasteric fasciæ. All these are blended together in the fibrinous effusion consequent upon the gradual severance by the pressure of the wires. The conjoined tendon of the internal oblique and transversalis muscles is firmly connected with the deep part of Poupart's ligament, and upon this union depend, for the chief part, the success and permanence of the radical cure. Thus the valvular arrangement of the front and hinder walls of the canal is restored and

Fig. 1141.

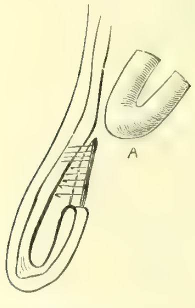


Diagram of cured inguinal hernia.

strengthened by adhesion, and the rounded knuckle of bowel can no longer enter the deep ring, and thus, the most effectual preventive of the formation of a hernia in the healthy inguinal canal, is restored and even strengthened by the operation. Unless this is accomplished, the cure is not a satisfactory one; and one of the chief causes of failure in the hands of beginners is the want of dexterity and experience in obtaining a hold upon the conjoined tendon with the needle-point, at the first stage of the procedure.

In some cases, no doubt, a want of substance and development in the conjoined tendon causes it to give way before the needle, and to tear under the traction of the wire. In other cases, where the hernial rings are large in diameter and close to one another, with no length of canal between them—as in direct herniæ, and in old oblique herniæ which have become, in effect, direct, and in which a patch or plug of invaginated tissue is necessary to supply an absolute deficiency of the abdominal wall—the inherent weakness will require afterward, perhaps, a longer, or even the continued use of a light truss. If care be exercised, however, in placing and keeping on a proper truss, such cases may be strengthened and fortified, so that the rupture may not return, and even if the groin remains weak and bulgy, and threatens to reproduce a rupture, ultimate success may be obtained. And in another class of cases, doubtless, adhesions, at first firmly resisting and efficacious (if not deposited when the patient is in robust health), may yield, under continued pressure, just as in other cases of operation for prolapsus of various kinds.

In less aggravated cases, the truss may usually be left off after nine or twelve months, the patient being at first careful to put it on occasionally, when likely to be called upon for much muscular effort.

A bulgy weakness of the groin may be apparent after the hernial canal is securely closed, from a want of development in the lower muscular and other fibres of the internal oblique and transversalis muscles; but this condition rarely requires more than the occasional use of a light truss, such as would be recommended for weak groins which had never been actually subject to hernia. When it is considered that in such cases, generally, no truss has been effectual in keeping up the rupture before the operation, the advantage gained by the latter becomes sufficiently convincing.

By the method just described I have operated upwards of two hundred times consecutively, with not a single seriously bad symptom occurring. The average period of convalescence has been about a month, from the operation to the healing of the lower opening; the average time in bed about eighteen days. Before adopting the use of wire, thread and compresses were employed, and while the steps of the operation were imperfectly understood and carried out, and when—perhaps still more important—cases were operated on somewhat indiscriminately, to see what could really be accomplished, three deaths occurred in the first 100 cases; one from pyæmia, one from erysipelas, and the third from peritonitis, all having been published at the time in the medical journals. Two of these cases were decidedly from hospital or other infection, while the third case was a peculiar one: the necropsy clearly showed that fatal peritonitis had been set up by a knuckle of intestine which had been involved in the sac before the operation, with the truss pressing upon it. The focus of inflammatory action was found around the damaged and congested loop of bowel, on the *opposite* side of the abdomen to that which was the seat of the rupture and of the operation. The sac operated on, and the peritoneum in its neighborhood, all around, were free from all traces or consequences of inflammation.

In no case has any trouble arisen from hemorrhage, nor have there been any signs of injury to the epigastric, femoral, iliac, or other vessels.

Success and Durability of the Results of the Subcutaneous Operation.—It has been justly urged that the immediate success of such an operation as that under consideration is not as fair a test of its worth as the permanence of its results. Fully impressed with this opinion, I have, at the expense of much pains and trouble, kept notes of three hundred cases, and have obtained the results given in the accompanying Table and Statistics. It has of course been extremely difficult to follow the cases operated on, derived as they have been chiefly from the very migratory working classes during a considerable number of years.

The first case given in the Table was one of very large scrotal rupture operated on at King's College Hospital, in the presence of the late Sir William Fergusson, Professor Partridge, Sir Spencer Wells, Mr. Henry Smith, and many other distinguished surgeons. Since the operation, the patient has been employed in very hard, laborer's work, and has, moreover, been severely tried by a winter-cough and bronchitis. He has worn no truss whatever, except for a few months immediately after the operation. He has been shown at various metropolitan societies and surgical assemblages, from time to time, at intervals of some years, and is well known to London surgeons interested in this operation. He has been shown at the London meeting of the British Medical Association, in 1873 ; at the Royal Medico-Chirurgical Society ; at the Royal College of Surgeons, on several occasions ; and on numerous occasions, at intervals, in the operating Theatre at King's College Hospital.

The seat of operation is sound and resisting, and is, in fact, better than the opposite side, which shows a slight bubonocele, from lifting and coughing. This circumstance serves to indicate the amount of strain that has been put upon the cured side during the twenty-four years that it has so successfully resisted, and the unyielding nature of the union when properly established.

The total number of cases which I have been able to keep in view, noting their condition from time to time with much care and trouble, amounts to fifty-six. They are given for the sake of convenience in the accompanying tabulated form, with the date of the operation, and the date when last seen by the operator, or, in a few cases, heard of from some other surgeon. It has been thought most convenient to place them in the order of the duration of time for which the rupture has been kept under notice and *known to be cured.* Many have been seen up to a late date, and many at various yearly intervals of which the last date is given. Two have been known to be cured up to the time of death from consumption ; others have dropped out of observation. The earliest cases were taken without much selection as to size and difficulty, and from a class of persons mostly proverbially careless as to the due application of trusses. Many wore no truss whatever after the operation.

In the later cases, after the operation had been tested and perfected, a more careful selection was made.

Table of Results of the Subcutaneous Operation for the Radical Cure of Inguinal Hernia.

No.	Name.	Age.	Date of operation, or of last operation.	Date when last seen.	Duration of cure about	Remarks.
1	J. B.	25	Jan. 11, 1862	June 6, 1881	19 yrs.	Very large; hard labor; no truss; shown at Med.-Chir. Soc.
2	H. H.	22	Oct. 6, 1860	Aug. 1, 1878	18	No truss for 15 yrs.; hard labor.
3	H. C.	28	Feb. 28, 1862	Oct. 1880	18	Heard of.
4	R. S.	6	Mar. 24, 1864	Nov. 15, 1881	17	Shown at College of Surgeons.
5	J. M.	25	June 25, 1860	Nov. 25, 1877	17	No truss at all worn.
6	H. W.	30	Nov. 1864	Dec. 1881	17	
7	H. H.	16	Oct. 6, 1859	July 16, 1875	16	No truss ; seen by Mr. R. Bell.
8	C. C. T.	10	June 5, 1865	July 19, 1881	16	Passed med. exam. for artillery at Woolwich 5 years ago.
9	H. W.	26	June 21, 1865	April 30, 1881	16	
10	M. B.	5	Oct. 1864	Dec. 1877	13	No truss worn.
11	G. P.	15	Oct. 5, 1861	Dec. 9, 1874	13	Operated on twice ; sailor.
12	W. A.	5	Oct. 1864	Oct. 9, 1877	13	Heard of again lately as well.
13	A. H. B.	40	Feb. 5, 1867	May 16, 1880	13	By letter from patient.
14	C. T.	18	June 28, 1862	April 1874	12	Seen many times.
15	J. B.	17	June 20, 1859	Oct. 5, 1870	11½	
16	J. C.	25	April 1, 1858	Oct. 20, 1868	10½	Slight bulging after a fall.
17	T. L.	18	Sept. 5, 1863	May 7, 1873	10	Double rupture.
18	F. H.	27	Nov. 8, 1871	Dec. 20, 1881	10	Operated on 3 times ; sailor.
19	D. W.	34	Sept. 5, 1862	June 10, 1871	9	No truss worn ; hard work.
20	W. R.	19	May 31, 1862	Jan. 1870	8	No truss.
21	C. T.	18	June 28, 1862	Feb. 1, 1870	8	No truss.
22	G. H. R. J.	28	Oct. 19, 1872	Mar. 5, 1880	8	No truss ; India.
23	L. D.	26	Mar. 1866	Jan. 1873	7	
24	T. N.	7	July 4, 1863	Dec. 28, 1869	6½	Brothers.
25	G. N.	9	Oct. 3, 1863	Dec. 28, 1869	6	
26	J. P. N.	24	Dec. 13, 1870	April 5, 1876	6	
27	M. S.	8	Nov. 15, 1872	July 1877	5	Both sides operated on same time successfully.
28	G. V.	21	June 2, 1860	Oct. 1865	5	
29	W. B.	32	Mar. 12, 1862	May 1867	5	
30	J. H. L.	4	June 22, 1871	Oct. 20, 1875	4½	
31	W. A.	24	Oct. 3, 1863	Nov. 7, 1867	4	No truss.
32	H. R.	23	Nov. 26, 1864	Nov. 28, 1868	4	No truss.
33	H. P.	23	Nov. 1864	Nov. 28, 1868	4	
34	H. C.	20	Oct. 5, 1868	Died 1872	4	Consumption ; no return.
35	G. R. A.	26	June 19, 1868	June 10, 1872	4	
36	J. D.	1½	Aug. 28, 1862	Oct. 1866	4	Truss 9 months ; seen often.
37	L. E.	26	Feb. 13, 1877	Oct. 1881	4	
38	J. A. T.	16	Oct. 5, 1872	Feb. 24, 1876	3½	Large scrotal.
39	E. B.	5	Dec. 20, 1873	Jan. 14, 1877	3	Very large ; congenital.
40	C. C.	40	Mar. 1864	April 1867	3	
41	E. P.	3	June 1877	June 19, 1880	3	Very large scrotal.
42	C. K.	8	April 1876	June 20, 1879	3	
43	J. S.	22	May 18, 1872	June 30, 1875	3	
44	W. S.	22	Mar. 29, 1862	July 9, 1865	3	Double scrotal.
45	G. T.	18	Dec. 1, 1869	Dec. 1872	3	
46	M. D.	18	Jan. 6, 1874	Jan. 1877	3	Passed army examination.
47	C. K.	8	April 1, 1876	May 20, 1879	3	
48	J. B.	26	Feb. 27, 1864	May 26, 1867	3	Female ; no truss.
49	R. H.	30	July 2, 1862	1865	3	Heard of.
50	J. P.	19	Mar. 30, 1878	June 1881	3	Both sides operated on same time.
51	D. S.	21	July 2, 1865	May 1868	3	
52	J. P.	19	Dec. 30, 1865	July 10, 1868	2½	
53	J. L.	13	Mar. 14, 1863	July 8, 1865	2½	Female.
54	H. C.	25	Mar. 1, 1878	July 1880	2½	
55	A. H.	22	Feb. 9, 1878	June 12, 1880	2½	
56	A. F. L.	20	Oct. 18, 1878	Oct. 1880	2	

All the patients of the foregoing table, it will be noticed, had remained cured for over two years before they were last seen.

In 62 other cases, the patients have been seen and kept under observation for periods less than two years, during which time the cure has remained satisfactory—in many without any supporting truss-pressure whatever. Most of these however, have, for the sake of security, worn trusses during the first twelve months after operation.

In 48 cases, I have ascertained that, at various periods from a few months to two or more years, the ruptures have returned. In most of these cases, however, trusses have been made available and efficient, which was not the case before the operation. The patients have been, in fact, made comfortable by the proceeding.

In no instance, as far as is known, has the case been made worse by operation. Although in many cases the operations have been failures, in a strictly scientific sense, they have by no means been so as far as the patient's satisfaction and comfort have been concerned; and the operation can scarcely be put down, therefore, as a futile effort to relieve suffering, any more than can the vast proportion of medical and surgical work which does not radically cure the patient, in the sense of relieving him for the whole period of his life, from a malady which nevertheless physicians and surgeons profess to cure.

Out of 300 cases of operation for the radical cure of inguinal hernia, then, 119 cases may be reckoned as having been kept under observation for varying periods of time afterwards, while 48 have been actually proved to be failures in the strict scientific sense. 167 out of the 300 have then been accounted for, leaving 133 which have not been seen or heard of since the operation, either from not having been able, forgetting, or neglecting to do what all had been earnestly requested to do, viz., to report their condition from time to time afterwards.

Now, when we consider that patients who are not cured, are more likely to return on the hands of the surgeon for further aid, than those who are cured are to come and report their state, or express gratitude, we may fairly infer that the percentage of success in those who have not been seen or heard of, has been rather more than, or at least equal to, that among those who have been examined after the operation.

Now, rather more than half have been seen or heard from, and of these nearly three-fourths are cured. We are justified, then, in concluding that the percentage of success obtained by the subcutaneous-wire method for the radical cure of inguinal hernia is from 70 to 75 per cent. in selected cases, when the operation is properly performed. This percentage, however, drawn from all, including the early operations, well and ill selected alike, has been improved by another 5 per cent. in the latter more carefully selected cases.

In some cases which have failed from various causes, such as the large size of the hernia, crying in a child, or carelessness just after the operation, a second operation, and in one case a third, has been performed with ultimate and complete success. Some were first operated on by my old methods with thread and compress, or with pins, and afterwards by the subcutaneous wire operation; of these there have been 12 cases, of which only one has failed utterly on both occasions.

In two, no truss whatever has been worn since the last operation, viz., G. P., No. 11 in the table, a sailor, aged 15, last operated (second time), October, 1861; shown at King's College Hospital, December, 1874; quite sound; no truss had been worn at all. M. A., aged 5, second operation, October, 1864; seen in 1877; had worn no truss and was an accomplished bicyclist. In an enormously sized scrotal hernia in a sailor, F. H., aged 25 (No. 18), the operation was repeated three times, each time with improvement, and with ultimate complete success. Last operation, November, 1871. Shown to a large assemblage of surgeons at the operating theatre at King's College, in May, 1881.

In 10 patients, both sides have been operated on, either at the same time, or with an interval:—

In one of these, J. P., a male, aged 19, the operations were performed in March and May, 1878, and the patient was shown at King's College Hospital in October, 1881, quite cured, no truss at all having been worn in the interval. In a boy, M. S., aged 8, the two sides were operated on at the same time in November, 1872. His medical attendant informed me, in 1877, that he was at school abroad, and quite cured. In one case, that of a child aged 1½ years, the operations on both sides failed entirely from the violent crying and struggles of the little patient, who made a good recovery from the operation, nevertheless. This was the only failure, with the exception of a slight bulge, if that can be called a failure, on one side only.

In some instances, where a weak bulgy appearance of the groin has remained after the operation, and has given rise to apprehensions of a return of the rupture, the application of a horseshoe-shaped pad of vulcanite for a year or so has consolidated the parts and completed the cure.

Wire Operation for the Radical Cure of Inguinal Hernia, with Removal of the Sac under Antiseptic Precautions.—This operation should be performed under the full use of the carbolic spray, and with the strictest antiseptic precautions. I accomplish the removal of the sac by a modification of the preliminary scrotal incision made in the subcutaneous method before described. Instead of a mere puncture three-fourths of an inch long through the skin and superficial fascia, an incision from two to three inches long, reaching as far upwards as the superficial abdominal ring, is made through the scrotal coverings right down to the sac itself, which is then detached from its investments, and lifted out and separated carefully from the spermatic vessels and vas deferens. This is best accomplished by a free use of the fingers and one or two pairs of forceps, or by the handle of the scalpel separating the sac from its coverings by tearing. Facility in this process, which in old truss cases may be found difficult, can only be obtained by frequent practice and experience. The greatest danger is to the spermatic duct and vessels, which are sometimes closely adherent to the inner and hinder surface of the sac, and covered by a dense fascia which appears to belong to, or to form, the sac itself. When the proper separation has been effected, and the operator has made sure of the return of the hernial contents, if reducible, the sac should be drawn out of the incision and detached upwards and downwards. Its attachment to the tunica vaginalis is sometimes so close that the testis may be drawn out and the tunic itself opened by mistake. This connection having been detached, the fundus of the sac is firmly lifted up into a vertical position. The incision in the integuments is now glided up so as to be well opposite to the inguinal canal, and the sac is then followed and detached from the cord as high up as the deep ring. The handled hernia needle is next passed through the neck of the sac, close to the fascia transversalis, and a stout catgut ligature, which has been steeped in a solution of chromic acid, is connected with the eye of the needle and drawn through double in withdrawing it. The loop of the double ligature is then cut, and the ends tied firmly with a surgeon's knot on each side. In doing this, great care must be taken not to include a loop of bowel, and to be the more certain of this, it is better to open the sac in front and pass the finger within it through the deep ring.

If the hernia be a congenital one, the lower part or fundus of the sac which should have formed the normal sac of the tunica vaginalis, and which is adherent to the testicle, and forms its serous covering, should be separated from the rest, on a level with the upper end of the testicle and epididymis, and stitched up with fine catgut in a glover's or continuous suture, to serve as the future tunica vaginalis. It will be found most convenient to place a pair of straight dressing forceps across the sac at the place indicated, then to sew the sac with catgut, and afterwards to cut it straight off above the suture.

If the hernia be irreducible, the sac must of course be first freely opened, the omentum drawn out and examined, any adhesion that may exist near the neck of the sac separated, and bowel carefully looked for. If a loop of bowel be found, but slightly adherent, the adhesions may be carefully separated, and the bowel returned. If the quantity of omentum in the sac be small, it may also be returned; but in case it is voluminous, diseased, or much adherent, it is better to tie its vessels carefully and separately with small catgut ligatures, and then to cut it off short with blunt scissors, afterwards securing any small bleeding points; care must be taken that the stump of omentum does not slip back into the abdomen before the process is completed. When the sac has been thoroughly examined, and the way cleared, its neck should be drawn out, separated, and tied in the way just described.

The wire may now be applied to the conjoined tendon and Poupart's ligament, as in the subcutaneous operation. Then there being no sac to be taken up in the scrotum, and the cord being sufficiently isolated and distinctly seen, the point of the needle may be passed across the lower part of the superficial ring, through the insertion of Poupart's ligament at the spine of the pubis, and obliquely through the conjoined tendon and inner pillar, about half an inch above the pubic crest. The inner end of the wire may next be hooked on to the needle, and drawn across on the inner side of the vas deferens and twisted on to the outer end, in the way described in the account of the subcutaneous operation. The lower part of the scrotal incision must then be drawn together by sutures, closely applied, a drainage-tube of the size of a quill being placed along the bottom of the wound, from the superficial ring above, and out at the end of the wound below. The protective and gauze-dressing may then be applied, the large, outermost dressing being provided with an opening for the penis, and the lower border being tucked under close behind the scrotum, to serve as a suspensory bandage with a sufficient amount of padding under it. The elastic bandage should be carried across the perineum from one thigh to the other, in addition to the turns of double spica on the groins. It will be well to pin over all a square piece of Jacquinette mackintosh, with a hole in the centre for the penis, to keep the dressings unsoiled by the urine. The use of the catheter is sometimes required for a day or two. On the third or fourth day the scrotal wound may be found united, and the stitches may then be withdrawn, and the drainage-tube shortened. The condition of the parts then resembles that seen in the subcutaneous operation, and the wires may be withdrawn on or about the tenth day. There is rarely trouble from any effusion of blood if the veins of the cord have not been cut, and if the drainage-tube is kept clear. A little swelling of the testicle, or effusion into the tunica vaginalis, if present, usually disappears without further treatment.

The severity of this operation is, of course, greater than that described as the subcutaneous-wire operation. It is modified, however, in cases of reducible hernia, where no omentum is removed, and where none of the abdominal viscera are involved in inflammatory complications. Its danger is increased by removal of any part of the omentum, adherent or non-adherent, by the omentum being diseased, or by intestinal adhesions having been separated. We may then have some local or general peritonitis.

These cases thus naturally fall, in respect to prognosis and fatality, into two divisions, viz., Those in which the operation is done for *reducible* hernia, and those in which it is done for *irreducible* hernia. If, however, great care be taken in the separation and ligature, by catgut, of all bleeding points in the omentum, mesentery, or adhesions of intestine, and if the antiseptic spray-

and-gauze method is successfully and conscientiously carried out, the danger of the proceeding is very much lessened. The number of cases in which I have, up to the present time, performed the above operation is 18; of these, 10 have been for reducible hernia, with removal of sac only; and 8 for irreducible hernia, with removal of sac and portions of omentum, adherent or non-adherent.

The first was done in July 13, 1878, for a large, right, scrotal, irreducible hernia, in a man, T. B., aged 26, admitted into King's College Hospital for severe symptoms of strangulation. The hernia, after some difficulty, was reduced by the taxis. The operation was done with antiseptic precautions, but not Listerism. There were no bad symptoms, and no elevation of temperature after the operation, and the patient was discharged cured, and without wearing a truss, August 3.

The second case was done April, 1879, in a boy, aged ten, for irreducible, large, right, scrotal hernia, in which a considerable portion of adherent omentum was removed with the sac. The result was very satisfactory, no bad symptoms ensued, and the patient was seen in November, 1881, perfectly well, having never worn a truss.

Of the 18 patients, only one has died, and all the rest have been cured.

The death occurred suddenly in a man, G. F., aged 45 (operated on January 11, 1881), from a clot in the heart and congestion of the lungs, three days after operation during the very severe snow-storm of that winter. Some signs of adhesive local peritonitis about the cut omentum were found, but the state of the sac and other parts operated on was all that could be desired. The operation had been undertaken at the patient's earnest request, on account of the dragging pains and weight of an enormous left scrotal rupture, filled almost entirely by adherent omentum, which was removed with the sac, after the arteries had been carefully tied with small catgut. The bowel was not adherent, and remained untouched and scarcely seen, and there was little or no bleeding during or after the operation. The patient's urine was free from sugar or albumen; but he had been subject to a bad, chronic winter-cough, which had aggravated his sufferings very much.

All the other cases have turned out satisfactory cures, some during nearly two years, and, what is still more encouraging, no dangerous or even troublesome symptoms have occurred. All were operated on and dressed with very careful, antiseptic, Listerian precautions. Most of those operated on later than two years ago, have been seen or heard of, from time to time, and no evidence has been forthcoming to show that the operation has failed to produce a radical cure in a single case. But, of course, the tests of number and duration have not been as extensively applied as in the case of the subcutaneous-wire operation.

From the statistics of the operation for the radical cure of rupture collected from various sources, different operators, and diverse methods—but all agreeing in a free dissection of parts, ligature and complete or partial removal of the sac, and the use of catgut or other ligatures variously applied, both with and without the carbolic spray and Listerian appliances—given by M. Tilanus, of Amsterdam, the percentage of deaths is found to be eleven per cent. This is too high a fatality to render an operation generally acceptable, in a condition which does not immediately or directly endanger the patient's life. The percentage of deaths after the use of my own method has been, as before said, at the rate of five and a half per cent. only, in sixteen cases. Further experience, and the careful employment of antiseptics, will still further reduce this percentage.

Wire Operation for Radical Cure of Inguinal Hernia after Strangulation.—Of such operations I have performed seven, with one death from pneumonia and delirium tremens, no serious symptoms having occurred in any of the other cases. The essential particulars of each case are as follows:—

1. M. W., aged 52. Large, right, scrotal hernia, of twenty-five years' standing. April 24, 1872, strangulation violent; herniotomy; a quarter of a pound of omentum removed, but not the sac, which was tied up with ligature-threads and left. A slough in the scrotum, and abscess, followed; no bad symptoms otherwise; patient seen again, wearing light truss and quite comfortable; no spray.

2. E. B., aged 21. Right scrotal hernia; taxis ineffectual; herniotomy; sac tied, but not removed; no spray; date of operation, March 23, 1873. Shown afterwards, in August, at a meeting of the British Medical Association, in London. Heard of seven years afterwards, as having had some return of the rupture, which was easily kept up by a truss.

3. W. M., aged 27. Right, scrotal, congenital hernia; strangulation; herniotomy without spray, catgut ligature, sac removed, December 10, 1873; no bad symptoms; discharged January 24; seen again in April 19; no bulge or sign of weakness.

4. H. S., aged 19. Left, scrotal, strangulated hernia of two years' standing; sac tied with catgut and removed, no spray, November 22, 1878; not seen since; a few months afterwards quite well.

5. T. B., aged 26. Large, right, scrotal hernia, irreducible from omental adhesion; strangulation of bowel reduced by taxis. Operation at once for radical cure under spray. July 13, 1878; sac and thickened omentum tied with catgut and removed; stump of omentum fixed to internal ring; progress very favorable; no suppuration. Discharged cured, wearing no truss, August 3, 1878. Has not shown himself since; parts very hard and resisting when last seen.

6. L. S. L., aged 23. Right testicle in groin, with an irreducible omental hernia and occasional strangulation of bowel; violent strangulation requiring herniotomy, done under spray, with gauze dressing; testicle, sac, and omentum removed after catgut ligature, November 13, 1878; able to go out of doors, December 14, no bad symptoms whatever, no suppuration. Examined in May, 1881; only a slight bulge apparent at site of deep ring. No trouble; light truss.

7. J. G., aged 44. Left scrotal hernia, large, of twenty-eight years' duration. A hard drinker, had had delirium tremens several times. No albumen or sugar in urine. Had had strangulation twice previously. Herniotomy, November 10, 1878; sac removed; spray and gauze dressing. Directly after operation (in which very little blood was lost), symptoms of delirium tremens set in, and the day after, those of pneumonia, followed by death, November 14.

In this case, the radical cure was attempted at the patient's earnest request, on account of the trouble and suffering which he endured with the truss, and the frequent recurrence of strangulation. There were no serious local complications in this case. The omentum was not removed, and the bowel was uninjured by the strangulation. The autopsy showed no signs whatever of local or general peritonitis. The neck of the sac was found to have been tied flush with the peritoneum, and all the parts concerned were unaltered by any morbid action; the serous membrane at the tied neck of the sac was slightly adherent. In Case 6, the strangulation was very severe and painful, and the steps of the operation very difficult, as they always are when an undescended testis is concerned. The progress of the case afterwards was absolutely free from bad symptoms.

In the first four of the above cases, antiseptic carbolic precautions were carefully observed, but neither spray nor gauze was used. I have, however, from observation of abdominal surgery, little doubt that in these cases, as in all herniotomies, the Listerian method of dressing gives considerably increased security in preventing putrefaction and suppuration, and also in diminishing or entirely preventing surgical fever, and in lessening the period of convalescence.

The amount of success in this procedure will depend in great measure upon a proper selection of cases. If after opening the sac in the necessary operation for the relief of strangulation, the intestine be found but little congested, and be not further injured; and if the omentum, though partly removed, be healthy as respects the stump; and if the patient be a healthy subject, with neither sugar nor albumen in the urine, of sober habits, and with a condition of solids neither flabby nor corpulent, and especially if he be young (under 30 years of age), the risks of the operation of herniotomy (rendered absolutely necessary by the irreducible strangulation) will be but little, if at all, increased by the steps taken to produce a radical cure. It cannot be too closely borne in mind that the risks in all such cases spring from disease or injury of the bowel and mesentery, and to a less degree of the omentum. I have not met with a single case in which pathological processes originating in the sac, except from erysipelas or pyæmia, have been the cause of death, or even of serious symptoms.

It is absolutely necessary to make a very careful inspection of the bowel, mesentery, and omentum, which should always be drawn down and examined for several inches, after division of the strangulating tissue. The neck of the sac should be tied with stout carbolized and chromicized catgut at the place where the division of the stricture has taken place. Catgut, however, cannot be relied upon unaided for preventing the return of the rupture. It is not persistent enough when placed in contact with the living tissues, even with the carbolic dressing, to withstand the strain of the aponeurotic and muscular tension in connection with the inguinal canal. This is clearly seen after sutures of catgut have been applied to close apertures in the skin under the carbolic spray and dressing. After a day or two they become attenuated, thinned, frayed, and elongated, even under the simple elasticity of the skin-structures, and unless immediate union of the incision has taken place, the wound reopens. In one case of large scrotal hernia, in a child of 7 years, in which I used stout carbolized and chromicized catgut instead of wire for closing the canal, the catgut gave way and the hernia was reproduced, although much thickening of the tissues at the deep ring was the immediate result. Catgut ligature, however, serves best for tying the isolated neck of the sac, there being, by its use, no necessity for subsequent disturbance of the parts, and it is efficient if supported by the wire ligature in the canal until union has occurred. Even more satisfactory results, however, have been obtained by the use of the tendons of the reindeer and kangaroo's tail, which are much more persistent than catgut.

Crural or Femoral Hernia.

From the greater width of the pelvis in the female, and from the increased length and diminished strength of Poupart's ligament in that sex, this form of rupture, in women, is more common than the inguinal, in the proportion of about two to one.

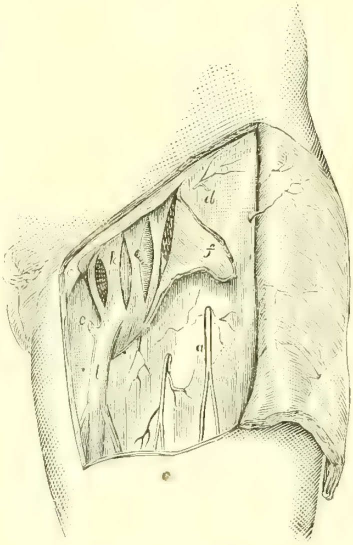
Anatomy of Crural Hernia.—In the lower half of the inguinal region, about half an inch below the inner third of Poupart's ligament, is placed the opening through which a crural rupture passes out of the abdominal cavity. It is exposed by making an incision through the integuments along Poupart's ligament, a second down the inside of the thigh, and a third from the lower end of the latter horizontally across the front of the thigh, at the junction of the upper and middle thirds. This corresponds to the area of Scarpa's triangle. The first layer of the superficial fascia is composed of adipose tissue, and is continuous with that over the abdomen. The deep layer is denser and thinner, and is attached to Poupart's ligament.

Between the two layers are found the *saphena vein*, to the inner side (see Fig. 1126, page 1127), with several of its tributaries accompanying the ascending branches of the common femoral artery, viz., the *superficial circumflex iliac*, passing upwards and outwards towards the iliac crest, and piercing the deep fascia at the outer third; the *superficial epigastric*, coursing upwards and inwards towards the umbilicus; the *superficial external pudic*, passing also upwards and inwards, crossing the cord just below the superficial abdominal ring; the *deep external pudic*, perforating the fascia lata and crossing horizontally behind the spermatic cord towards the penis. Lying along the saphena vein, on both sides, are the lymphatics of the lower inguinal region, ducts and glands. The former receive tributaries which pass with the vessels just mentioned, and the latter, of an oval shape, with their long axes corresponding to the axis of the body, chiefly over a depression indicating the opening in the deep fascia which transmits the saphena vein, and through which the lymphatics make their way into the crural canal, and thence to the iliac glands in the abdominal cavity. A few nerve-twigs are also met with, viz., branches of the *ilio-inguinal*, which pass with the spermatic cord through the superficial abdominal ring, and turn downward and outward over the end of Poupart's ligament, to be distributed over the adductor region of the thigh; and a crural branch of the *genito-crural* nerve, which perforates the deep fascia about an inch below the middle of Poupart's ligament, and joins with the middle cutaneous branches of the anterior crural which are distributed over the middle of Scarpa's triangle. The internal and external cutaneous branches of the same nerve perforate the deep fascia much lower down in the thigh.

The *fascia lata* of the thigh is thus exposed to view, thick, dense, and grayish white, with little or no fat except where the vessels and nerves pierce it, covering the femoral vessels and crural nerves, and inclosing externally the sartorius muscle in its sheath. Above, the fascia lata is blended firmly with that portion of the external oblique aponeurosis which forms Poupart's ligament along its whole length. This is called the iliac portion of the fascia lata (see Fig. 1126, *m*, page 1127). The inner portion, which covers the adductor muscles of the thigh (Fig. 1126, *n*), is attached above to the symphysis pubis, the pubic spine, and the pectineal line, where it blends with the triangular offset of Poupart's ligament which is called *Gimbernat's ligament.* Outside of this, the pubic portion of the fascia lata passes behind the femoral vessels and is blended with the capsular ligament of the hip-joint. The pubic portion thus dips deeply behind the iliac portion, which overlaps it at the inner third of the thigh, and between them is the *saphenous opening.* This is an oval opening, from an inch and a half to two inches in its longitudinal diameter and three-quarters of an inch transversely. When dissected, it is seen to present an external arched or curved border, the upper part of which (*Hey's*, or the *femoral ligament*) curves inwards to the pubic spine and pectineal line, across the crural canal, where it is about half an inch wide, and so strong as sometimes to cause strangulation in a crural hernia. At its lower part, the curved border of the saphenous opening arches under the saphena vein, forming a sharp curve, the *falciform process* of Burns. On the inner side, the opening is bounded by the sloping surface of the pubic portion of the fascia lata. The opening is covered in by a fascia which is closely adherent to the latter internally, and to the edge of the falciform process and Hey's ligament externally. This covering is continuous with the deep layer of superficial fascia. It is perforated by numerous openings for the passage of the lymphatic ducts into the crural canal, and for the superficial epigastric and external pubic vessels, which curve upwards. It is closely adherent to these as well as to the coats of the saphena vein below, from which it cannot be separated.

On turning aside the falciform margin of the iliac portion of the fascia lata by detaching it from Poupart's ligament (Fig. 1142, *f*), the sheath of the femoral vessels is brought to view. It is a funnel-shaped investment (*k*), wider above than below. Its front wall is formed by a prolongation of the fascia transversalis behind Poupart's ligament, to which it is closely attached, the union forming a band of fibres which arch over the crural opening (*Cooper's ligament*), to be attached to Gimbernat's ligament and the pectineal line internally. This forms the most usual seat of strangulation in crural hernia. The hinder wall of the femoral sheath is formed by a prolongation of the iliac fascia. It is continuous at the sides with the transversalis offset, and below, at the junction of the saphena vein with the femoral, it is intimately blended with the sheaths of those vessels respectively. On the inner side, the lymphatics can be seen to perforate this sheath in numbers. The funnel-shaped process should be opened by three parallel longitudinal incisions, when it will be found that two septa in the interior separate the femoral vein (which is in the centre) from the femoral artery outside and the lymphatic canal inside. The latter is the channel through which crural hernia passes. It constitutes a section of an inverted cone, the base of which is formed by an interval between the septum of the femoral vein outside and the curved base of Gimbernat's ligament inside. The apex is formed by the junction of the saphena vein with the femoral, at the lower part of the saphenous opening in the fascia lata. The sides of the canal are thus of unequal length. Superficially and internally the extreme width of the falciform or Hey's ligament expresses it, viz., half to three-quarters of an inch. Behind and externally, the length is one and a half to two inches.

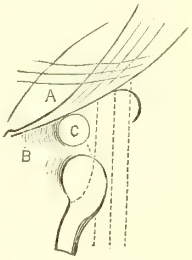
Fig. 1142.



Deep dissection of the parts in crural rupture. The upper corner of the saphenous opening is separated from Gimbernat's and Poupart's ligaments and turned back, showing the three compartments of the crural sheath opened by longitudinal slits.

The *crural ring* (Fig. 1143, *c*) is thus bounded in front by the inner end of Poupart's ligament (*a*) with the fibrous band of Cooper's ligament over-arching the canal; internally are the blended margins of the structures attached to the pectineal line, viz., Gimbernat's ligament (*b*), with the conjoined tendons of the internal oblique and transversalis muscles and the fascia transversalis behind it, and in front the extremity of Hey's or the femoral ligament and the pubic portion of the fascia lata, joining at the upper edge of the saphenous opening. The area of the crural ring is placed nearly horizontally in the erect posture of the subject, with a slight slope upwards, outwards, and forwards; across it is stretched a curtain, derived from the subperitoneal connective tissue attached to its edges, perforated by the lymphatics, and usually containing a lymphatic gland enveloped in a sheath of the

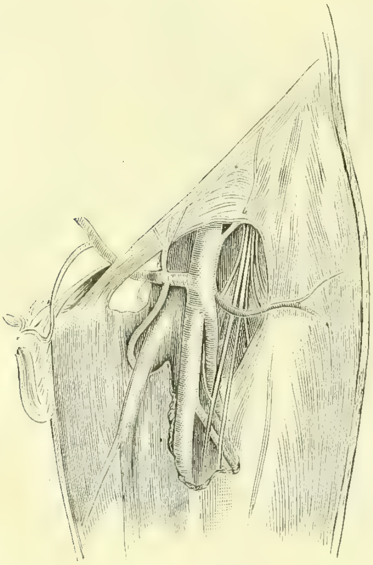
Fig. 1143.



The crural ring.

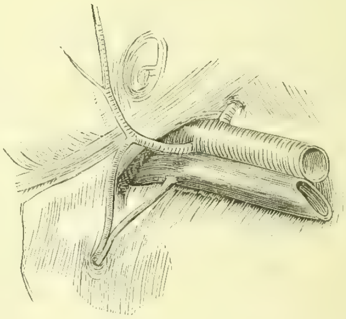
same tissue. This horizontal fascia is called the *septum crurale* of Cloquet. It offers no considerable opposition to the descent of a hernia, and is so indistinguishable from the fascia transversalis in a hernial condition, that it is of no practical use to the surgeon. On dissecting the crural ring from its peritoneal surface, it will be seen, on raising the serous membrane, that a slight dimple usually indicates the position of the ring, and that the *deep epigastric vessels* lie external and superior to the opening, arising from the external iliac. Sometimes these vessels are irregular. They may arise from the common femoral, as low down as the saphenous opening, or in common with the internal circumflex, in which case the epigastric will pass through the crural ring. (Fig. 1144.) The epigastric artery may give off the *obturator*, usually a branch of the internal iliac. When this is so, the obturator may either pass down into the pelvis, close to the external iliac vein, and therefore external to the crural opening (Fig. 1144); or it may pass over the latter, behind Poupart's ligament, and descend along its inner margin, just behind Gimbernat's ligament. (Fig. 1145.) It is the latter rare position that concerns the surgeon in operating for strangulated crural hernia, since in dividing the ligaments freely the operator may divide the irregular artery. The arrangement, however, occurs so rarely that this seldom happens; one in five is about the proportion found in the dissecting-room, and not one in a thousand, perhaps, on the operating-table. It can be guarded against by not passing the hernia knife (which should not be too sharp) too far into the abdominal cavity, when its point will push off the elastic and yielding artery before it, without cutting it. The irregularity is produced by an enlargement of the normally existing branch of communication between the epigastric and the obturator arteries.

Fig. 1144.



Irregular arrangement of arteries concerned in femoral hernia.

Fig. 1145.



Irregular course of obturator artery.

A crural hernia first makes its way by pushing before it from the peritoneal surface the sac and septum crurale on its surface, its direction being downwards and a little forwards; it then enters the crural canal, dilates

Fig. 1146.

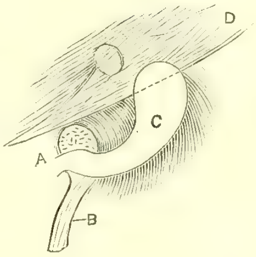


Diagram of crural hernia.

the sheath, and bulges out the cribriform fascia; then, being prevented from passing down the thigh by the close union of the last-named fascia with the coats of the saphena vein (Fig. 1146 *b*), and following the line of least resistance, it turns over the outer edge of the saphenous opening (*a*), and passes upwards and outwards under the integuments (*c*), lying upon the femoral vessels, and even passing above Poupart's ligament (*d*), so as to give the appearance of an inguinal bubonocele. It is thus exposed to severe pressure, first from Gimbernat's ligament and its associated structures, and the band of Cooper at the crural ring, where the point of strangulation is most frequently found at or in the neck of the sac itself; and next, from the sharp, curved border of the saphenous opening (Hey's ligament), where the direction of the axis of the sac is changed to one upwards and outwards. It follows that the direction of force in the taxis of a complete and large femoral hernia should be inwards and downwards upon the fundus of the sac, and directly backwards at the neck of the sac, so as to avoid pressing the bruised bowel against the sharp edges which lie above and outside it. It follows, also, that when an operation is required, the hernia knife should be directed inwards and forwards, so as to divide Hey's ligament and Gimbernat's ligament together, in a line almost parallel with the superior ramus of the pubic bone. If this is not sufficient to release the bowel, the deep fibres of Poupart's (constituting Cooper's) ligament should be further divided by directing the knife more forwards, care being taken, in the male subject, not to cut so far as to divide the spermatic cord in the canal which lies just above those structures.

Diagnosis of Strangulated Crural Hernia.—This condition may be mistaken for certain local diseases coincidently or causatively attended by constipation, vomiting, nausea, and other alvine symptoms. The most common of these are *enlarged femoral glands*, which, when placed upon the saphenous opening, or within the crural canal, may resemble closely a small hernia. When not acutely inflamed, they are movable; of the characteristic, oval, glandular shape; often multiple; and extending down with their long axes in the direction of the saphena vein. When inflamed, they are indurated and œdematous, the pain and tenderness extending down the thigh; at the same time an examination of the feet will often reveal the cause of the glandular irritation. When suppurating, the fluctuation in the centre of the lobulated and indurated mass will, when punctured, explain the appearances.

A *varicose saphena vein*, enlarged into a globular tumor at the saphenous opening, increasing in tenseness and size on standing, and disappearing almost entirely on lying down, feeling elastic, and yielding to the touch, may be mistaken for reducible crural hernia.

The appearance of varicosity in the same vein or in its branches lower down, a certain dusky complex color, characteristic of varicose veins, and a want of fulness over the crural canal in the groove over Poupart's ligament, will help to diagnose this condition. The point of a finger placed firmly on the crural canal while the patient lies down, and the pressure kept up when he changes to the upright position, will keep back a hernia; but a varicose swelling will, under the same circumstances, immediately return. But, if in such a varicose condition the vein becomes plugged by a clot in the same position; and if the patient is affected with constipation or nausea at the same time (as lately occurred in a pregnant patient who was under my observation), the difficulty of distinguishing it from an irreducible, or even a strangulated crural hernia, becomes extreme, and may only be cleared up by careful observation of the progress of the case, and of the effect of aperient remedies.

A *lipoma* may be found in the crural canal, so closely simulating omental hernia as to require an exploratory operation for its distinction and removal.

A *cystic* formation in the crural canal may give rise to similar perplexity. Such cysts may arise from the sac of a small hernia, which has become cut off by adhesions from the peritoneal cavity, or from degeneration of the lymphatic ducts or glands. They are usually more movable than a real hernia.

Other *tumors*, of an adenoid or sarcomatous nature, may exist in this situation, and may be distinguished by the same criteria, viz., their hardness to the touch and lobulation, together with their persistent and steady growth.

Psoas, or pelvic, or iliac *abscess* may simulate crural, as well as inguinal hernia, with or without abdominal complications, and may be distinguished by the means already pointed out in the remarks on inguinal hernia.

When these means of distinction fail, and the complication of general and abdominal symptoms of a serious character still more perplexes the surgeon, an exploratory incision, under antiseptics, will alone clear up the matter; and this may be extended into an operation for the relief of strangulation, if required. "When in *intelligent* doubt, skilfully operate," is the proper maxim for safety.

Operation for Strangulated Crural Hernia.—The patient having been placed on the operating table, and an anæsthetic having been administered to its full effect, a final effort should be made with the taxis; in case of failure, the parts being shaved and the carbolic spray in action, a straight incision of a size proportionate to that of the tumor (averaging two inches long), should be made through the integuments a little to the inner side of the axis of the crural canal. The superficial external pudic, or epigastric, as the case may be, should be secured by twisting, or with a small catgut ligature. Then upon a director, the cribriform fascia and femoral sheath should be divided, and the subserous adipose tissue covering the sac carefully opened up to the femoral ligament. The curved hernia-director being carefully passed under this, it must be divided up as far as to the fibres of Poupart's ligament, and then, in recent cases, an attempt should be made to reduce the contents of the sac by digital manipulation, as recommended by Mr. Luke. If this does not easily succeed in recent cases, and always in cases where long strangulation or symptoms of mortification have occurred, the sac should at once be opened by pinching up a portion at the centre, and dividing it with the point of the scalpel, placed horizontally; the contents of the sac should then be examined by passing the finger up to the edge of Gimbernat's ligament on the inside of the bowel. When the stricture is found, the point of the curved hernia-director should be insinuated under the edge of the deep crural ring and Gimbernat's ligament, and the hernia-knife passed, not too deeply, and directed inwards, so as to divide the constricting fibres. The director should then be lifted so as to dilate the opening. The omentum and bowel are next drawn gently and carefully downward so as to examine the constricted parts. Any ulcerated point at the neck of the hernia, opposite the strangulation at Hey's and Gimbernat's ligaments, should be looked for; adhesions should be carefully separated; and the omentum and bowel should then be returned into the abdomen, or otherwise treated, as described in the case of inguinal hernia. The same rules as to sphacelated parts, and ulceration or sloughing of the bowel, are to be followed in all cases of strangulated hernia.

There is very rarely any trouble from an irregular course of the obturator artery. If profuse bleeding, whether arterial or venous, should occur at the crural opening after the return of the bowel, the aperture should be dilated—by division, if necessary, of Poupart's ligament—and the bleeding point exposed and secured with a small catgut ligature.

If the bowel is ulcerated through by the pressure of the aponeurotic fibres, the part above is commonly adherent to their edge. Under such circumstances the gut should not be detached, nor the adhesions meddled with, after division of the stricture. The intestine should be left undisturbed, and not cut into unless clearly sphacelated. By this means, the formation of an artificial anus is often prevented, especially with the aid of the spray and gauze dressings. A small drainage-tube, or a bundle of horsehair or catgut, having been placed in the lower part of the wound, three or four points of suture should be applied, and then a small pad of gauze on each side over the protective oil skin; then the whole should be well padded with wet and dry gauze, especially towards the inner side. The entire dressing should be well secured by a spica bandage, and the patient placed in bed, with the knees bent over a bolster.

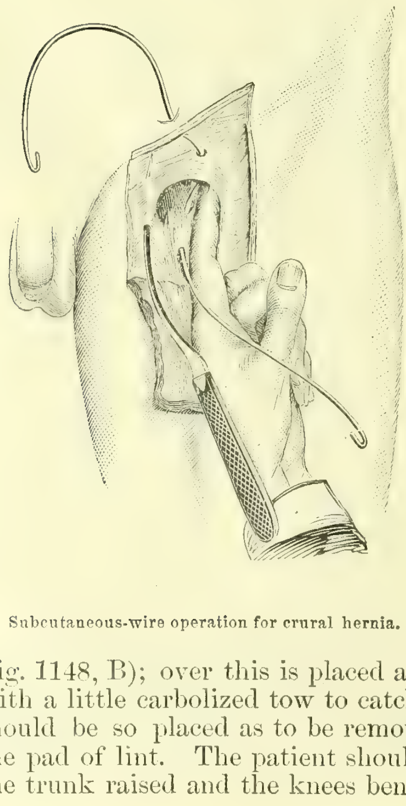
DIAGNOSIS OF UNSTRANGULATED CRURAL HERNIA.—The most important point in these cases is to make sure whether the tumor in the groin is one which requires truss-pressure, or one which would be injured by it. The latter group includes the cases of enlarged glands, especially those acutely inflamed, and abscesses, which have already been considered. Obliterated hernial sacs and adipose tumors are often benefited by light truss-pressure. Cysts and varicose tumors in this situation are usually aggravated by it, unless, in the latter instances, the truss is soft, light, and accurately fitted. When the question of an operation for the radical cure is raised, the size of the neck of the sac and the nature of the contents are important. If the former is small and the latter omental, there is more chance of success than under opposite circumstances. The general diagnosis of the tumors which simulate crural hernia has been already discussed. Another important point is the distinction between crural and inguinal hernia, which in very stout persons is sometimes by no means easy. It has been treated of at length in the section on the diagnosis of inguinal hernia, at page 1133.

OPERATION FOR THE RADICAL CURE OF CRURAL HERNIA.—The importance of, and necessity for, this operation, is generally by no means as great as in the case of inguinal hernia. In the first place, it is of much less frequent occurrence, and, in the next, it is by far most commonly found in females, whose less laborious employments and whose more flowing garments render the wearing of a truss more efficacious and less irksome than in the male sex. Still, there are instances wherein it is desirable, for both patient and surgeon, that a radical cure should be attempted before the operation for strangulation is needed; and when the latter is required, a radical cure can be accomplished without increased risk, while the coverings of the hernia are divided. In the upper and middle classes, truss-pressure is always more or less irksome, and to some tender skins painful and wearisome; and in the working classes, women often have employments which require much muscular effort, as is the case with market-women, milk-women, etc.

The exigencies of parturition also present conditions in which a rupture becomes a source of danger; and the desirability of a radical cure is further increased by the greater difficulty of getting a steady and unshifting bearing for the truss-pad, since the movements of the thigh are more felt in crural than in inguinal hernia.

Steps of the Subcutaneous-Wire Operation for the Radical Cure of Reducible Crural Hernia.—The patient being placed upon the table and anæsthetized, with the leg of the affected side slightly flexed and turned a little outwards, the parts should be shaved and purified with 1–20 carbolic solution, in which the instruments and wire should also be laid. The hernia should be reduced and the finger passed into the crural ring to make sure that nothing is irreducible. An oblique incision, three-quarters of an inch or an inch long, is made through the integuments and fascia covering the sac of the hernia, which is then invaginated upon the finger into the crural ring. The finger is to be pressed firmly outwards against the femoral vein, so as to empty it and push it out of the way of danger; the pulsation of the femoral artery will be plainly felt in doing so. The same needle as that used in the like operation for inguinal hernia, but rather smaller in ordinary cases, is now passed along the finger till its point reaches Poupart's ligament, through which it is to be passed at a point opposite the inner margin of the femoral vein. When the point raises the skin, this is to be drawn outwards for about an inch before the point of the needle is pushed through. The wire (about fourteen inches long, and bent at each end into a hook) is next hooked on to the needle's eye, drawn down into the incision, and then detached. The finger must now again be invaginated and pressed firmly against the edge of Gimbernat's and Hey's ligaments; the needle is then to be pushed through the fascia lata, which covers the adductor and pectineus muscles, and then carried along through Gimbernat's ligament and the insertion of Poupart's ligament into the pubic spine. (See Fig. 1147.) The skin is now to be drawn inwards until the point of the needle appears at the upper puncture, through which the wire already passes. It is then pushed through the same puncture, and the hook at the other end of the wire attached and drawn down through the incision. When the sac is large, it may now be transfixed or wholly included by the needle being passed across or behind it, pinching it up between the finger and thumb. The two ends of the wire are then to be twisted twice around each other, and the upper loop pulled so as to invaginate the sac into the ring (Fig. 1148), and then twisted down into the puncture, as in the inguinal operation. The ends of the wire are then to be cut off to a convenient length, bent over towards the bent-down loop, passed through the loop, and fastened by a bend. A pad of carbolized lint is then passed under the loop and made to cover the wound (see Fig. 1148, B); over this is placed a little oiled silk, and then a spica bandage, with a little carbolized tow to catch any drainage that may occur. The last should be so placed as to be removable and replaceable without disturbing the pad of lint. The patient should be placed in bed, with the upper part of the trunk raised and the knees bent over a bolster. The wire may remain a

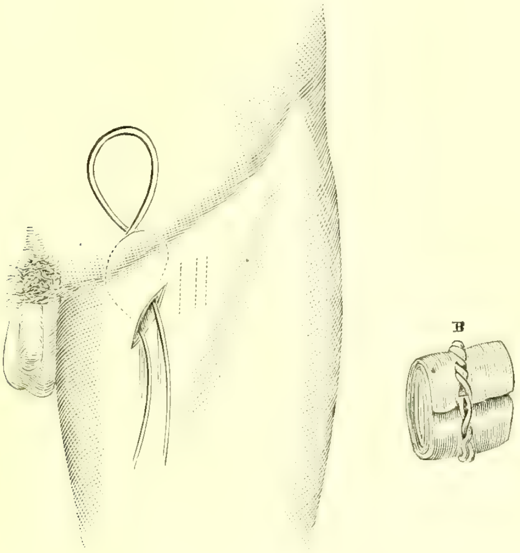
Fig. 1147.



Subcutaneous-wire operation for crural hernia.

week or ten days, when it can be removed, after being untwisted, without difficulty, as the wires by this time will have ulcerated through the tissues, so as to be in close proximity, and will often lie in the same track. The drainage is kept free by the lower end of the twisted wire while it is in place. When it is withdrawn, the dressings should be so arranged as to allow the pus free exit.

Fig. 1148.



Mode of securing the wire.

When cicatrization has been completed, a soft truss-pad of an oval shape (as described in the section on trusses) should be applied over cotton wool and dusting powder, and subsequently replaced by a harder, vulcanite pad.

Operation after Herniotomy for Strangulation.—When under the spray the sac has been opened, the stricture divided, the bowel and omentum drawn down and examined carefully, and the former found not essentially injured, with no ulceration at the strangulated part, and no appearance of sphacelus, the operation should be concluded by tying up the neck of the sac by strong catgut, at the level of the crural ring, and cutting off the sac just below. If the sac be large, the catgut should be made to transfix it, and should be tied tightly on each side. Then after passing the needle through Poupart's ligament on the one hand, and through the pubic fascia lata and Gimbernat's ligament on the other, as above described, the needle should again be passed horizontally through the pubic fascia lata, just below its insertion into the pectineal line, and the inner end of the wire hooked on and drawn through. Then the two ends of the wire should be twisted together, and the loop drawn up and twisted firmly down into the upper skin puncture. A drainage-tube should next be placed in the lower part of the wound, reaching as high as the closed crural ring, and two or three points of suture applied. Upon the protective, a double pad of wet, carbolized gauze should be placed, so arranged that a groove is left to lodge the end of the drainage-tube, and to give free exit for any discharge.

Then the rest of the antiseptic dressing is to be applied, with plenty of loose padding, especially on the inner side, to absorb the discharge, and a spica bandage above all. If the discharge does not soak through, the dressing may be left for three days, when, if primary union has occurred, as is most likely, the stitches may be removed and the drainage-tube cleansed and reapplied, shortened by about half an inch. In another three days the dressing should be changed, and the wire removed, the tube, again shortened, being kept in till the next dressing in three or four days more. The tube will then generally require removal.

I have operated for the radical cure of crural hernia by the wire operation, directly after the operation of herniotomy for strangulation, in four cases, all in women. In the first two the spray was not used, but all the other antiseptic precautions were employed. In the last two, the spray and Lister's dressing were used. All the patients recovered without a bad symptom, each having a good, firm, resisting cicatrix; no return of the rupture has occurred, as far as known, up to the present time.

1. H. S., aged 50, a woman, bedridden from paralysis, with a chronic cough which caused the bowel to come down under the truss, when it often became strangulated. Left crural hernia; a large part of the tumor was irreducible. The truss gave her much pain and trouble, from slipping down and causing excoriations, of which the marks were very visible. Strangulation symptoms severe for thirty-six hours. Operated on October 28, 1879. A considerable portion of omentum, ecchymosed and congested, was removed after being tied in sections with thin catgut. The sac was then tied and removed, the ligature (of stronger catgut) being made to lay hold of the stump of the omentum. Stitches, drainage-tube, and dressing of carbolized lint, covered with a large pad of carbolized tow, and secured by a spica bandage. She made a good and rapid recovery; never wore a truss, and, when last heard of, was more comfortable than she had been since she had had the hernia.

2. A. S. H., aged 35. Strangulated left crural rupture; for forty-eight hours, vomiting of fecal matter; herniotomy operation, May 9, 1879. Patient had bronchitis at the time of operation; sac removed, and operation done without spray; good recovery. Discharged June 8; wore no truss after a few months; seen December 5, 1880, one year and three-quarters after operation, quite well.

3. F. D., aged 30. Right crural strangulation for twenty-four hours; severe pain and vomiting; herniotomy under spray, September 28, 1880; no omentum; bowel chocolate-colored; sac removed after ligature by catgut wires applied as above; no symptoms afterwards. Discharged cured, October 15; seen in January, 1881, quite well.

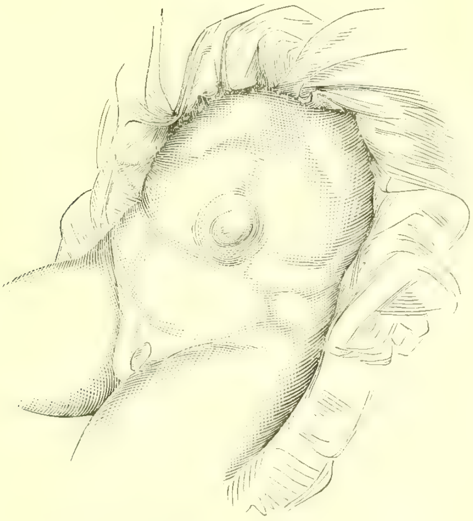
4. E. O. N., aged 56. Right crural strangulated hernia, irreducible omentum. Strangulation forty-eight hours; bowel chocolate-color; omentum adherent. Omentum removed with sac; operation with wires as above, May 26, 1881. Discharged cured, June 21, 1881. Heard of afterwards as quite well.

We should no doubt be prepared to expect a higher rate of mortality in this operation than in that upon unstrangulated herniæ. Very much will depend upon the care and judgment of the surgeon as to the condition of the bowel and omentum, before venturing to return them into the abdomen, and upon his choice of cases in which strangulation is recent. With due caution we may expect confidently that no higher rate of mortality than is met with in ordinary crural herniotomy, will be experienced. And if so, it certainly seems to be a shortcoming in surgery not to take advantage of the open wound, to cure, if possible, the hernia, by the same operation as that which is necessary to relieve strangulation. It is well known that by not doing so, the hernia is left to become larger and more troublesome to retain, because of the crural ring being cut so as to be more open and unprotected than before the operation. To be successful, as a rule, cases must be operated on as soon as possible after a fair trial of the taxis, aided by inversion and anæsthesia, has been made. But this rule, also, operates favorably in an operation which is usually successful in saving the patient in inverse proportion to the amount of damage done, chances lost, and time misemployed by ill-directed and unskilful use of the taxis or other futile methods of treatment; and this especially in thin, feeble, female patients after the middle period of life.

UMBILICAL HERNIA.

ANATOMY OF UMBILICAL HERNIA.—Two varieties of umbilical hernia present themselves to the surgeon. One is congenital, and is seen in infants and children at or soon after birth (Fig. 1149), and the other (probably also dependent in some measure upon the same original weakness) is found in adults: in women whose abdominal walls have become distended from pregnancy—especially from multiple births, from a large child, with a narrow pelvis in a small woman, or from a large quantity of liquor amnii—or, in both sexes, from corpulence consequent upon adipose deposit in the omentum, or from dropsy in the peritoneal cavity.

Fig 1149.



Umbilical hernia.

Congenital umbilical hernia is so common in both sexes as to be considered by Sir Astley Cooper to come next in frequency to inguinal hernia. In the development of the fœtus, the last part of the peritoneal cavity to close into a shut sac is at the navel. The aperture through which the omphalo-enteric duct of the yelk sac or umbilical vesicle passes to the intestine with its omphalo-mesenteric vessels, is occupied in its upper part by these structures bound together by the reflected tube of amnion, while the lower part is occupied by the urachus, or tube of communication of the allantois sac with the bladder, and with it, passing upwards from the pelvis in front of the peritoneum, by the placental (afterwards the hypogastric branches of the internal iliac arteries), and, passing downwards from the liver, by the umbilical or placental vein. About the third month of intra-uterine life, the umbilical vesicle and the omphalo-enteric duct, with its vessels, begin to shrink, and finally disappear. In cases of slow and late development, a thread-like pedicle can be seen even at the full period of gestation. Soon afterwards, the tubes of the urachus, occupying the lower part of the umbilical opening, shrivel and close up. And here again we occasionally find a delay in development, and at birth there may be a patulous opening at the navel, through which a little urine may trickle. In more decided cases of very early arrest of development in this region, we may have produced the deformities known as ectopia vesicæ and epispadias. The hypogastric arteries and umbilical vein persist until birth is fairly accomplished. Sometimes the reflected tube of the amnion, the *vagina funiculi umbilicalis*, is found to pass into the umbilical cord and to contain a portion of small intestine even at birth. In such cases the navel-string is of unusual diameter close to the fœtus, and compressible, dilating when the child cries. Care must be taken not to include the intestine by tying the cord too close to the body of the child in such cases. Here is an intra-uterine formation of umbilical hernia, rendered more decided and kept open by the struggles and crying of the newly born infant. And at this point is the original weakness of the navel, in cases of congenital umbilical hernia, to be looked for.

When this condition is detected at birth, it is best, after the ordinary ligature and division of the navel-string at about an inch and a half from the abdomen of the infant, to squeeze out of the persistent sac all traces of the presence of intestine or omentum, and then to tie the cord again firmly close to the surface of the abdomen. By this means the occurrence of an umbilical rupture may be prevented during the cries of the child soon after birth. The developmental tendency to close up the navel-opening is very strong, and requires only a little aid from art to secure its accomplishment.

On each side of the opening is one of the broad, expanded recti abdominis muscles, inclosed in the split sheath of the internal oblique, fortified on its posterior part by the tendon of the transversalis, and on the anterior by that of the external oblique muscle. Opposite to the navel is found one of the linear, tendinous intersections of the recti muscles, pursuing an irregularly horizontal course, and closely adherent to the enveloping tendinous sheath. On the inner side, the sheaths of the two recti muscles are united in the median line by crossing and interlacing fibres, forming the *linea alba*, so that those of one side pass over by a decussation to the opposite side of the abdomen. At the navel, the linea alba is at its widest part, and a close dissection will show that some of the fibres at this point are arranged so as to surround, in a parabolic curve, the opening for the umbilical vessels. These curves, arranged in different directions, give the effect of a circular arrangement to the investing fibres, which by this contraction tend powerfully to close up the umbilical opening. The closure is aided also by the contraction and consequent widening of the bellies of the recti muscles in expiratory and expulsive efforts. The contraction of the oblique muscles also aids, by the cross pull which it exercises upon the decussating fibres at the navel. To some extent the traction of the pyramidales muscles, which are proportionately largely developed in the infant, and are also attached to decussating and more or less longitudinal fibres, contributes to close up the umbilical opening. It may easily, therefore, be inferred that, up to the period of puberty, exercise of the abdominal muscles by proper gymnastics will aid in the cure of congenital umbilical hernia.

The fascia transversalis in the umbilical region is thin, but tougher and with closer fibres than in other parts of the abdominal wall, and it is here blended closely with the decussating fibres of the linea alba. The serous peritoneum is also thinner, tougher, and more closely adherent than elsewhere. In congenital hernia the sac is usually very thin, and its covering often consists only of the transformed cutaneous investment of the umbilical cord itself.

The *umbilical herniæ of adults*, unless they are a continuation of the infantile, differ somewhat in their origin and anatomy. They sometimes pass through the true navel-aperture, but more frequently through an aperture close above, or below, or on one side of it. After some distension, the umbilical cicatrix becomes involved, and it and a part of the skin cover the tumor, which is not quite in the centre, but usually below it. An examination of the anatomy of the front abdominal wall, will show that there are numerous small openings near the linea alba, through which pass small branches of the intercostal arteries and nerves. Usually these openings (some of which are also found in the sheaths of the recti proper) are filled up with small nodules of connective or adipose tissue. When the person gets corpulent, these nodules increase in size, while the openings in the fibrous network become larger by stretching, and then, if the individual gets thinner, from any cause, the openings become more patulous, and are imperfectly filled by adipose processes from the sub-peritoneal fat joining on to the subcutaneous adipose structures. Under a violent expiratory exertion—such as a cough, or straining or forcing effort—a portion of peritoneum is driven into the opening, and a small sac is formed. These sacs are not uncommonly found in subjects in the dissecting room before a regular hernia has been the result. They may also be seen near the inguinal region, and in several cases a rupture has been found to pass into the inguinal canal, simulating an oblique inguinal hernia, but not covered by the infundibuliform or cremasteric fascia. They may occur at various parts of the abdomen, and form ultimately true *ventral* herniæ.

Umbilical hernia in the adult has a thin and closely adherent sac, sometimes so attenuated by distension as not to be recognizable by the surgeon, who may in operating come suddenly upon the contents of the rupture. The contents of an umbilical hernia in adults are almost always omentum, usually loaded with fat, and often thickened and hardened by inflammatory effusion from external pressure, to which its situation exposes it in an unusual degree. In children, umbilical hernia usually contains small intestine, with a thin covering of omentum, or entirely without it. In adults, the colon is often contained in the sac; sometimes in its whole diameter, sometimes one of its cells pinched up into a pouch. In rarer and larger cases a part of the stomach, duodenum, liver, gall-bladder, cæcum, sigmoid flexure—or even the uterus, ovaries, or bladder—may be found in the sac. The proximity of the hernia to the stomach, and its hold of the omentum high up, usually causes a great amount of dragging pain, nausea, and sickness, while its implication of the colon causes frequent constipation, flatulence, colic, and distress.

Sometimes a double opening is found in the interior of the hernia, either with two distinct sacs, or with two necks to the same sac. The latter arrangement often results from the remains of the urachus and hypogastric arteries at the upper part of the superior false ligament of the bladder, traversing the interior of the sac to the navel-cicatrix, with adhesions to the neck and with a pouch on each side, one of which may contain omentum, and the other large or small intestine. The suspensory ligament of the liver has been seen to form a similar division of the sac. The point of strangulation in an adult umbilical hernia is most frequently at the lower part of the neck of the sac, where the action of gravity, the dragging weight of the contents and the super-incumbent fat, together with the pressure and weight of the dress or of an abdominal belt, combine to press downwards upon the sharp edge of the abdominal opening. It is here that adhesions and ulceration of the bowel are most frequently found, and here the surgeon must search for the constriction in cases of strangulation. The coverings of the hernia consist chiefly of the integument, often attenuated by stretching, and under it a thin prolongation of the deep fascia, with fibres from the aponeurosis of the linea alba. These are usually blended intimately with the serous peritoneal sac, with but little subserous connective tissue.

Diagnosis of Umbilical Hernia.—Umbilical hernia in the child may be mistaken for dropsy of the funis, or for a sarcoma or carcinoma growing from or near the navel, or for a cyst. It may be distinguished by its dilating impulse on crying, and by its compressibility and total disappearance on continued, gentle pressure. In the adult, it is most likely to be mistaken for a fatty or other tumor; it is also distinguishable by the above signs, and by its getting larger or smaller as the patient stands or sits up, or lies down; by its tympanic sound on percussion when it contains bowel; by its yielding on being kneaded when it contains feces, and by its flatulent croaking and borborygmus when it contains air. Impacted feces, causing obstruction of the bowels, give a peculiar, lumpy feel, and may be sometimes distinguished from hardened masses of omentum by assuming different shapes under pressure. In one case, seen by myself, rounded masses were felt, which were found to be intra-peritoneal concretions of coagulated albumen, like billiard-balls, which had found their way into the sac. I have also found like concretions in inguinal and crural herniæ of old standing. They seem to be formed by deposits of coagulable lymph upon nuclei of fat, in shape and structure resembling the "appendices epiploicæ" which have afterwards become detached, leaving a mark indicating their former connection. In ascitic patients, an umbilical sac may be filled with fluid and contain no viscera.

Treatment of Umbilical Hernia.—Congenital umbilical hernia in children under puberty is rarely, if ever, strangulated. It tends naturally towards a cure, and requires only the aid of proper and efficient pressure to accomplish it. For very young infants, nothing is better than a penny-piece wrapped up in adhesive plaster, with the sticky side outward, placed on the opening after carefully pressing the contents into the abdomen, with the point of the finger. Over this pad, transverse straps of soap plaster, one inch wide, and long enough to reach well over the sides of the abdomen, should be firmly applied, and a light flannel belt over all. This should be changed whenever it begins to curl off or to slip down, and the skin in the neighborhood should be well cleansed and dried, and then dusted with starch-powder to prevent excoriation. The common practice of putting on a conical pad of cork cannot be too much deprecated and condemned. Any plug passing into the umbilical opening, although apparently making it more secure against slipping, tends powerfully to prevent, instead of aiding, in the closure of the aperture. In the section on Trusses will be found a description of the pads which I employ to produce a radical cure of umbilical hernia, and from the use of which, in older cases, many cures have resulted. They should be employed whenever the adhesive plaster makes the child's skin sore and excoriated.

The truss which I use for reducible umbilical hernia, in adults, will be found described in the section on Trusses. That for irreducible hernia should be an air-pad, in the hollow of a concave, thin, German-metal plate, fitted on to the tumor, the edge of which is protected by a rounded air-pad, to prevent it from chafing the skin around. This should be held in place by a laced belt coming down to the groins, with elastic side-pieces. The thin plate protects the rupture from injuries or violent pressure in front.

In the application of the taxis to the umbilical hernia of children, simple pressure between the finger and thumb, the child being in the recumbent posture, will, in most cases, suffice, if persevered in gently and persistently.

In large herniæ, and in fat women with obstructed or complicated herniæ of long standing, the fundus of the tumor, if large enough, should be first lifted up so as to avoid pressing its neck against the lower edge of the constricting opening. Then the whole tumor should be gently kneaded and compressed (as directed heretofore), so as to press out any flatus and feces that may be present. The occurrence of *borborygmus* is a favorable sign. Then any inclosed bowel may pass into the abdominal cavity with a sudden flop, and the omentum, very often adherent, will remain as a soft doughy mass, which will usually give little trouble, unless the inflammation of the sac end in suppurative action, as it sometimes does. Too much pressure should not be used, and if the tumor be very tender, or the symptoms of sickness, etc., very severe, or if the obstruction persist after the use of oil and turpentine enemata, and fomentations, an operation for the relief of strangulation should be had recourse to. This operation, on account of the frequency of morbid changes in the contents of the rupture, and the nearness of its site to the sympathetic ganglia, stomach, and liver, is of a more dangerous character than in other cases of hernia. The continued application of ice to the hernia is also to be avoided, for the same reasons, and also because of the thinness and abnormal congestion of the hernial coverings, and the close proximity of the enfeebled bowel to the cold ice-bag, endangering mortification.

OPERATION FOR STRANGULATED UMBILICAL HERNIA.—An anæsthetic having been administered, and the patient placed on the back, with the shoulders raised, and a last effort at the taxis having been made, the tumor, if large, should be lifted up from the abdomen below, and, under the carbolic spray, an incision from two to three inches long, in the median line, should be carefully made, the thinness of the walls being borne in mind. The incision should extend below the navel-cicatrix, down to the lower border of the hernial opening, in order to obtain good drainage after the operation, as well as to bring into good, open view, the lower edge of the strangulating ring and the viscera in contact with it. The sac should be carefully opened on a director; but before doing so a towel, wet with warm 1–40 carbolic lotion, should be spread on the abdomen on each side of the hernia, to receive and inclose any intestines that might fall or be forced out. The anæsthetic should be regulated at this time, so as to prevent cough-straining as much as possible. The sac should be pinched up with forceps, and opened, with the scalpel held horizontally. Into the opening thus formed, after being enlarged by the fingers, the broad hernia-director should be passed downwards, and upon it the sac slit up in the median line, carefully avoiding the bowel. The loop of strangulated gut should now be gently lifted up, and the curved director passed over the lower constricting edge of the hernial opening into the abdomen, and this edge cautiously divided with the hernia-knife sufficiently far to relieve the strangulation. The bowel and omentum should then be examined closely. If the former be ulcerated by the edge of the opening, the soft adhesions should be separated, and the injured part of the bowel placed opposite the opening in the skin, the gut being drawn a little out of the abdominal cavity to prevent any danger of fecal extravasation into the peritoneal cavity. If the bowel be fairly sphacelated, as indicated by its loss of lustre, deep black color, and putrefactive smell, an opening should be made in it, and the sides should be stitched with thick, soft silk, steeped in carbolized oil, to the edges of the cutaneous incision. One or two stitches may be put in on each side, before the bowel is opened, to prevent retraction, and a vessel, or large warm sponges, should be held ready to receive the fecal outpour. If the bowel be intact, and only congested, of a chocolate color, it may be returned. The omentum, which should at first be turned up over the upper edge of the hernial opening, may now be examined. If diseased or sphacelated, the vessels should be tied where they are evident, with fine catgut, carried around them with a common sewing-needle, and then the mass should be cut off with blunt scissors; all bleeding points should be carefully tied. No haste should be used, unless urgently needed at this part of the operation, so as to be sure that all bleeding is permanently stopped; the edge of the omentum may now be so arranged as to meet the lower, cut edge of the hernial opening, and become adherent thereto, so as to prevent, if possible, any future protrusion. The omentum should not, if possible, be tied "en masse," or in a puckered bundle.

It sometimes happens that adhesions of the omentum form the strangulating agency, and not the hernial aperture. If this be so, the adhesions must be cut or separated, and the bowel released. All bleeding points are to be carefully tied with small catgut ligatures.

In corpulent persons, in whom the operation has been delayed until peritonitis has begun, the operator has frequently to contend with a gush of bowels out of the abdomen. This should be restrained by receiving them in the warm wet towels, and applying pressure by the hands of assistants. If it can be managed, all the operative proceedings within the sac should be done before such a rush occurs; but if a cough, or vomiting, or anæsthetic difficulty occurs at this juncture, this is sometimes impossible, and the surgeon is compelled to do the best he can. In such cases the operation becomes a formidable one indeed, and is comparable only to laparotomy under conditions of inflammatory distension of the intestines. The bowels and omentum should always, if possible, be kept in the warm wet towels, and not indiscriminately handled by the assistants, whose arms should be bared, and well purified with carbolized lotion. The intestines should be always returned before the omentum, which should, if possible, be spread out over them before the stitches are applied. These should be put in very closely and numerously, taking up the serous membrane as well as the skin. A drainage-tube should be placed in the lowest part of the wound. If it be small, and with no distension of the abdomen present, the sac may be entirely removed, with a portion of the thin skin over it, and the wound may be then brought together with thick silver-wire sutures and leaden buttons, taking a good hold of the recti muscles and sheath, the skin being united by close points of silk suture, and the whole covered by gauze dressing and a broad flannel bandage. If an artificial anus is unavoidable, the sutures should be closely applied to the living edges of the bowel, uniting them to the skin so as to prevent subsequent extravasation. In this case further use of the spray is unnecessary and inconvenient. The opening, after free evacuation of the contents of the bowel, should be lightly covered by carbolized lint, over which a quantity of loose carbolized tow should be laid, and the whole secured by a broad flannel bandage lightly applied.

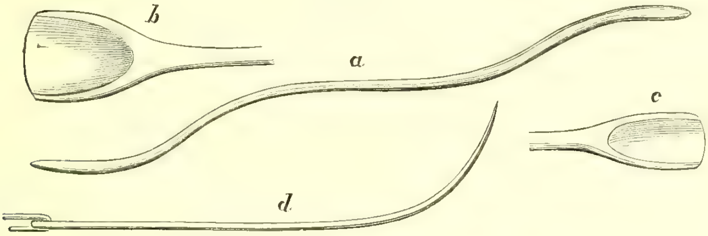
The apartment should be kept at a temperature of 60° F.,[1] and a "bronchitis-kettle" should furnish steam while the operation is going on. Sickness may be allayed by sucking small lumps of ice; and a grain of opium, in the solid form, may be given every four hours, unless albumen or sugar be present in the urine, when the effects of each dose should be closely watched before another is given. If the stomach reject all medicines, the sedative may be administered by hypodermic injection. No enemata should be given for a week after the operation. The wire and buttons, when used, should not be removed before this time has elapsed, and before the median wound has become well united. In cases of artificial anus, the bed may be deluged with the contents of the bowels. This complication is best met by placing large quantities of carbolized or marine tow under and on each side of the patient.

[[1] A temperature of 70° F. would be preferable in America.]

RADICAL CURE OF UMBILICAL HERNIA.—In congenital cases, properly treated, a radical cure by the use of truss-pressure may be confidently looked for. In early infancy, the condition of the navel should be carefully examined. If a tendency to swelling at the root of the funis be observed at birth, when the infant cries and struggles, the stump of the navel-string should be pressed firmly between the finger and thumb, and a thick silk ligature, or a very narrow piece of tape, should be tied firmly around it at the level of the skin, and kept on until it ulcerates through, so as to produce adhesion of the persistent vagina funiculi umbilicalis. Afterwards the penny-piece should be applied, and if the parts get excoriated by the plaster, an India-rubber belt, with a pocket to receive the coin, or a flat piece of lead, opposite the rupture, is the best application. If this be carefully attended to, the weak place will be closed before the age of puberty. If it persist beyond this, or if it prove unmanageable at an earlier period, as is often the case among the children of the poor, a subcutaneous operation by wire may properly be had recourse to.

Subcutaneous Operation by Wire.—For this proceeding, a copper wire silvered, thin enough to be pliant, and made warm and pliable by brisk rubbing, with a hook at each end; a handled needle, with a medium curve, and stout and sharp enough to pierce the very tough structures concerned (or a stout, strong, common suture needle (see Fig. 1150 *d*), in default of this), are needed. A spoon-shaped director (see Fig. 1150 *a*, *b*, *c*,), to guide the needle, will be found also serviceable to guard the bowel from possible injury. The child being laid upon its back, and thoroughly under the effect of an anæsthetic, any protrusion should be carefully returned into the abdomen, and the director, well oiled, should then be pressed into the hernial opening, and its edge pushed a little upward, and laterally, well under the tendinous margin of the umbilical ring. Then, its handle being firmly depressed and steadily held by an assistant, the needle should be passed through the invaginated skin, the tendinous aponeurosis, and the skin at the side of the navel, a little above the centre, the latter being drawn up before the needle pierces it by traction with the fore-finger (see Fig. 1151). If a handled needle is used, one hook of the wire should now be attached and drawn through. Then the director should be pushed well downwards and laterally, and the needle should be passed again through the hernial coverings and through the aponeurosis, so as to take a good hold, when its point should be directed so as to come through the same aperture in the skin as before (see Fig. 1152), a manœuvre which is aided by drawing the skin down a little with the point of the finger. The other end-hook of the wire is then to be attached and drawn through, so as to leave a loop of wire projecting through the skin-puncture. The same manœuvres are next to be effected on the opposite side of the hernial opening, the needle being passed through the same punctures in the hernial covering, and the

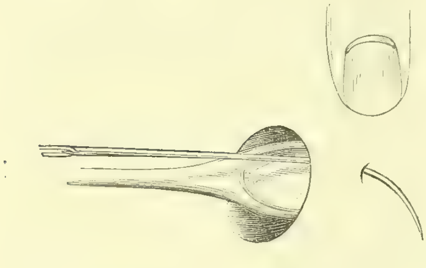
Fig. 1150.



Instruments used in operation for umbilical hernia.

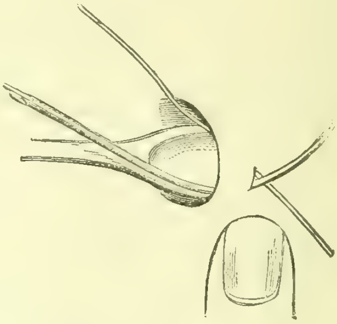
ends of the wires being drawn upon until the middle portions have sunk through the punctures in the hernial coats. The ends are then to be twisted down into the side puncture by two twists, and brought over so as to hook into the loop. If a common suture-needle be used, two wires must be employed, and both ends twisted. (See Fig. 1153.) A firm pad of lint, bent so as to fit over the projecting and crumpled-up sac, is now placed under the bridge of wire (see Fig. 1154); a padding of lint is put at the sides, and a light bandage is applied around the body to keep all steady. The wires may be kept in until they ulcerate through the inclosed tissues (in about a week or ten days), and the newly united parts must be carefully supported by pad and bandage, and dressed with simple cerate, until cicatrized. An elastic body-belt, and a flat, hard, circular pad, of three inches in diameter, placed in a pocket of the belt in front, should be worn for six or twelve months to support the union.

Fig. 1151.



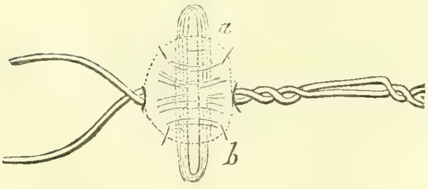
Introduction of the first wire.

Fig. 1152.



Introduction of the second wire.

Fig. 1153.



The ring closed by twisting the wire.

Fig. 1154.

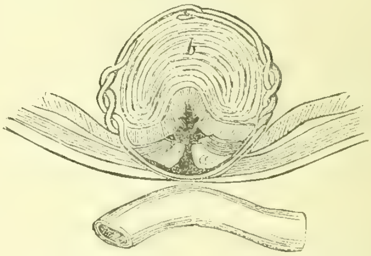


Diagram showing closure of ring.

I have performed this operation in six cases of hernia in children, which had baffled all contrivances for truss-pressure.

In one case, a lad, F. M., aged 14, the hernia was about the size of a walnut, and the patient had been refused admission to the navy in consequence. He was operated on with wires, December 6, 1867; and in the year following the cicatrix was found, on examination, to be hard, firm, and resisting, with no cough-impulse whatever, and with much retraction of the navel.

In none of the cases were any serious symptoms observed, and none of the ruptures are reported as having returned, although the patient's friends were earnestly requested to inform me if any recurrence should take place.

In two cases, in which the sac of an umbilical hernia of considerable size was removed during the operation of ovarian laparotomy, the sides of the hernial opening were united by wires and leaden buttons in sewing up the abdominal wound, and the cases did very well, the removal of the sac not having had the smallest apparent influence upon the progress of the case. In one, however, apparently from the general lax and stretched condition of the abdominal walls about the linea alba, the resulting cicatrix, both at the site of the umbilical hernia and below it, where no hernial sac had existed, remained in a weak condition, necessitating the wearing of a belt.

In the most common cases of umbilical hernia, attended with corpulence, a fatty condition of the omentum, and general constitutional debility, these circumstances, as well as the age and habits of the patient, preclude any attempt at a radical cure of the rupture by operation, and the best thing that the surgeon can do is to fit on a hollow truss-pad and abdominal belt. The pad should have a large, hollow plate or disk of thin German silver, moulded to the shape of the rupture, when so far reduced by taxis as to be comfortable to the patient. In the hollow should be fitted an air-pad of India rubber, with an India-rubber tube placed on the rim, to prevent its cutting in or chafing when the belt is tightened up; the belt should fit well down into the groins, should have elastic side-pieces, and should lace up behind.

Ventral Hernia.

Ventral herniæ, near the usual site of umbilical hernia, rarely allow of interference for a radical cure, from the causes just explained regarding the latter. When small, and placed near the inguinal region, however, they may sometimes be dealt with on the same principles as inguinal herniæ, especially if passing partly through the inguinal canal or external ring. Sometimes they make their appearance in one of the lineæ semilunares, with an aponeurotic sac, especially after distension from pregnancy; or they may arise after a wound, or after an operation such as laparotomy. An abdominal belt and pad, as just described for umbilical hernia, is the best application in most cases. If they become subject to strangulation, which is rare, the operation should be conducted in the same manner as that already described for umbilical hernia.

Obturator or Thyroid Hernia.

This is a rare form of hernia. Covered by a sac derived from the pelvic pouch of peritoneum, it dilates and passes through the opening formed by the passage of the obturator vessels and nerves below the superior pubic ramus. In a case of this kind, fatal from strangulation, great pain was felt passing down the thigh in the course of the obturator nerve. In another case, however, in which the late Mr. Hilton opened the abdomen unsuccessfully in search of an internal obstruction, and found a small knuckle of bowel strangulated in the obturator opening, this important symptom was not observed. In a patient with symptoms of internal strangulation, there was a slight degree of fulness in the upper and inner part of Scarpa's triangle, inside the femoral artery and the saphenous opening.

The surgeon, Mr. Obrè, made a straight, exploratory incision over this tumor, down to the saphenous opening, where a hardness was observed under the adductor portion of the fascia lata. On dividing this fascia and the pectineus muscle below it, a hernial sac was exposed, rising into the wound to the size of a pigeon's egg. The sac was opened, and some small intestine exposed; the strangulating edge of the obturator opening was divided, and the intestine returned. This bold and thoroughly scientific proceeding was fortunately successful in saving the patient. The saphena vein was wounded accidentally, and tied.

For a hernia of this kind, a truss like that for crural hernia, but with a longer and more depressed spring, should be tried. In a case giving great trouble and endangering strangulation, an operation for the radical cure—removing the sac, and closing its neck and the hernial opening by the application of a strong, carbolized tendon-ligature—would be admissible on the principles already laid down.

Ischiatic Hernia.

This variety of hernia is still more rare. An obscure and small tumor felt under the gluteus muscle, with local pain, tenderness, and symptoms of intestinal obstruction or strangulation, would justify an exploratory operation under antiseptic precautions, division of the strangulation, ablation of the sac, and closure of the opening by tying its neck in the way above described. From the position of such a hernia, it is not likely that any form of truss-pressure could be successfully maintained.

Perineal, Vaginal, and Pudendal Herniæ.

Perineal hernia comes down between the bladder and rectum, with a sac of peritoneum, through an opening in the pelvic fascia and the fibres of the levator ani, forming a tumor with the characteristics of hernia, in front or to the side of the anus. A truss may be adapted for this on the same principle as that made by the instrument-makers for supporting piles or prolapsus of the rectum.

Vaginal and pudendal herniæ are varieties of the preceding, projecting into the vagina or pudendum in females. The pudendal must be distinguished from the labial variety of inguinal hernia, in females, which is the homologue of the scrotal variety in the male, and which is more commonly found than the one under consideration. The absence of any protrusion in the inguinal canal, or in the upper part of the labium, in the latter, affords an easy means of diagnosis between the two, taken together with the presence of a tumor at the side of the vagina. When strangulated, these forms of hernia will be made more detectable by local tenderness and pain, as well as by the general symptoms. They should be reduced by pressure with the fingers on the vulva, and also, if necessary, through the vagina and rectum, with the patient in the recumbent position, and the pelvis elevated on pillows. They may be kept up by the use of a vaginal, elastic-ball pessary, combined, if necessary, with a spring perineal truss.

Diaphragmatic Hernia.

Diaphragmatic hernia may occur from a wound by a lance, spear, sabre, or gunshot-missile, passing obliquely through the peritoneal cavity into the pericardium or pleura; or by separation of the fibres of the diaphragm, or dilatation of the œsophageal opening, by violent pressure, such as that of a cart-wheel passing over the abdomen, or a heavy body falling upon it.

The latter accidents usually result in rupture of the liver, spleen, or other abdominal viscera, and prove speedily fatal. The liver powerfully protects the diaphragmatic openings against any hernial results of undue pressure of the intestines. The occurrence of strangulation from such a rupture gives rise to the symptoms which characterize internal strangulation, but the determination of the position of such internal constriction will be helped by the local pain, by impaired action of the heart or lung respectively, and by tympanic resonance over the pericardium or pleura, as the case may be; while, perhaps, in cases which are not strangulated, gurgling may be heard through the stethoscope in the same situations. In one case recorded by Copeman, of Norwich, the hernia was pleural, and gave rise to pain in the shoulder. Guthrie proposed, in such cases, to make an opening into the abdominal cavity, and to introduce the hand in order to withdraw the bowel from the hernial opening; and, no doubt, this ought to be done when the history and symptoms of the case are sufficiently clear.

Trusses.

On the proper construction and exact adaptation of trusses, depends a vast amount of comfort or of suffering in the numerous patients who are affected with hernia. And the proper choice and application of trusses should be made a subject of study and experience by every one practising surgery, nor should the patient be left (as is too often the case) to the mechanical mercies, and rough and ready adaptations, of the instrument-makers and chemists who sell these appliances. Space will not permit more, in this place, than a description of the kinds of trusses and belts which I have found most successful in practice, and will allow of no reference to the great variety of articles which their inventors and makers offer, by advertisement, to that portion of the public which needs this kind of surgical relief.

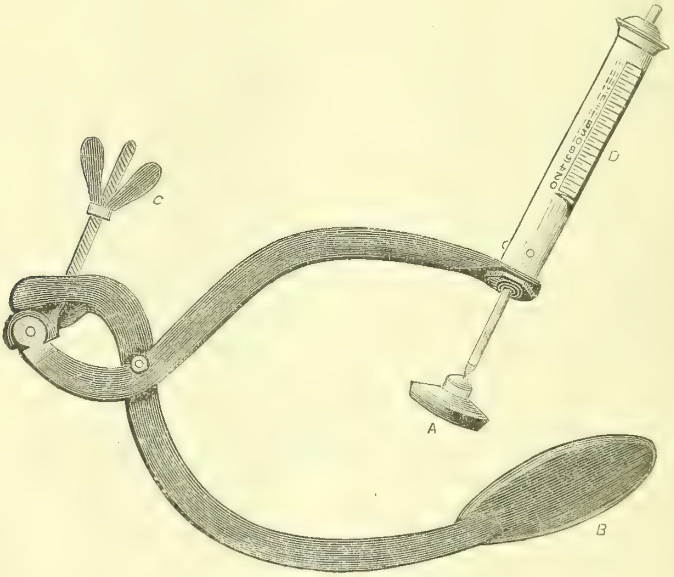
Trusses may be classified most usefully under two heads, viz., those which are intended to afford the greatest possibility of the chance of an ultimate radical cure (a possibility which is usually small and uncertain), and those which are intended to make the patient comfortable by giving support, and to avoid the dangers of strangulation. For the former purpose, the patient must be content to endure some inconvenience from the more firm and effective pressure required for the sake of the full chances of a cure by this means. For the latter object, the efforts of the maker should be to make the patient comfortable, as far as may be compatible with keeping the rupture in the abdomen, or preventing its increase and further descent.

In all cases, however, the practice which is too commonly followed, of rendering easier the adaptation of the truss and aiding the pad to keep its place by making it so conical as to press into the hernial opening like a cork into the neck of a bottle, should be carefully avoided. The introduction of such a plug from without, acting upon yielding and distensible structures, is unscientific, and instead of counteracting the dilating influence of the viscera from within, is calculated to increase ultimately, instead of diminishing, the size of the rupture. The constant boring movement produced by the motion of the side-spring in walking or any other form of exercise, has invariably this effect when kept up long, as is demonstrated by the deep, pit-like depression left in the integument when the truss is removed. The investing structures are pushed into the hernial apertures, and produce the same dilating effect from without as the protruding viscera do from within. A bubonocele is thus met half way in the canal, and is assisted, by the dilatation of the superficial aperture, to become a complete hernia. The more complete the adaptation, and the better the fit of this kind of truss, the more speedily are its mischievous effects made evident.

The truss-pad should have its surface as nearly flat as its adaptation to the body will permit, should be shaped according to the form and outline of the rupture, and should be as large as can be conveniently worn. It should press upon the walls and sides of the hernial canal quite as much as upon its centre, and should be so inclined as to face a little in the direction of the hernial canal. In a corpulent patient, it should be so inclined as to lie flat upon the sloping integuments. The spring should be of sufficient strength to resist protrusion in ordinary expiratory efforts, such as coughing.

For the purpose of measuring the force required, before the truss is fitted, an instrument made for me some years ago by Matthews, is very useful. (See Fig. 1155.) By placing the piston-pad (*a*) of this instrument, in truss fashion, upon the rupture, and the plate (*b*) upon the sacrum, then closing the lever arms by the screw (*c*) until some supporting resistance is felt by the patient, a cough-impulse will be imparted to the spiral spring placed within the projecting cylinder, and can be read off on the indicator (*d*), which shows in pounds the amount of pressure necessary to restrain the hernial protrusion. Violent and extraordinary efforts in coughing or straining cannot be effectually resisted by any amount of truss-pressure which can be continuously borne by the patient. The truss-spring, under such circumstances, should be helped by pressure with the hand upon the pad, during the continuance of the cough or straining. No contrivance which has hitherto been employed to substitute the steel side or hip spring is effective in giving real support to the rupture in cases of inguinal or crural hernia. Straps and belts are yielding, and incapable of such a degree of lateral resistance, when passed in a circle round the body, as to be effective at the point required.

Fig. 1155.



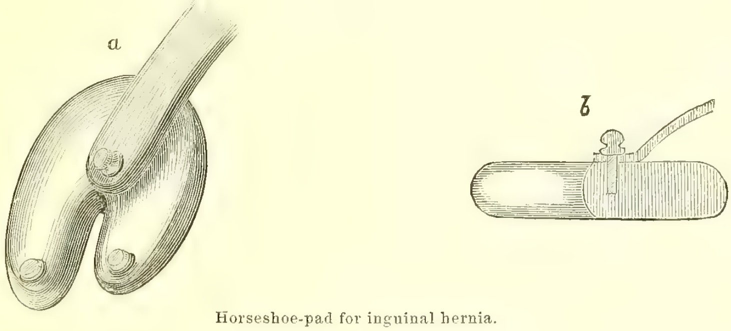
Pressure-gauge, for ascertaining the amount of hernial impulse, and consequent strength required for truss-spring.

Trusses for Inguinal Hernia.—One of the first essentials in the truss-pad for this kind of rupture, is that it should not press upon, or interfere with, the circulation or other functions of the spermatic cord. Not uncommonly the cord becomes jammed by the downward pressure of the truss-pad upon the crest of the pubic bone below. The consequences are pain and uneasiness along the cord and in the testicle. The latter slowly enlarges if the pressure be continued; effusion takes place in the tunica vaginalis, and a hydrocele or a hydro-sarcocele is gradually formed. In other cases, the pressure upon the spermatic veins of the cord gives rise to varicocele. This condition is sometimes the result of the continual pressure of a rupture alone, but more frequently it results from the combined pressure of the rupture and of an imperfectly adjusted truss. It is more likely to occur in cases where a radical cure is attempted by means of firm truss-pressure with a hard pad.

In order to avoid the two dangers of increasing the size of the hernial aperture by using a too conical pad, and of making undue pressure upon the cord, I devised, some years ago, a horseshoe-shaped truss-pad for the treatment of inguinal rupture. In cases where a radical cure without operation is sought, the pad is made of vulcanite or of compressed gun-cotton. Both these substances have a firm, perfectly smooth, and unirritating surface, which is capable of being washed clean every morning, and of being thus freed from the irritating and acrid accumulation of the decomposing secretions of the skin, which give such an unpleasant odor, and produce such an irritating effect upon the skin, in the leather-covered trusses in common use. When perfectly cleansed, and dusted with powdered starch, these pads can be very comfortably worn when properly adjusted.

The pad for oblique inguinal hernia is made with a flat surface, rounded off smoothly at the borders, and of the shape of an oblique horseshoe, with the outer or inferior limb shorter than the inner or superior. A cleft about three-fourths of an inch long and half an inch wide, intervenes between the ends of the horseshoe (Fig. 1156); this is for the lodgment of the spermatic cord as it lies upon the groove of the outer pillar of the superficial ring, external to the pubic spine, which is also placed, when the truss is properly fitted, in the cleft or groove. The mobility of the healthy spermatic cord is so great, that, when the pad is placed upon the inguinal canal so that the cleft is opposite to the pubic spine, looking downwards and inwards towards the testicle, the cord slips into its proper place under the pressure of the ends of the pad, while the upper, rounded border presses upon and prevents protrusion through the deep or internal abdominal ring. The spring is fixed by a screw upon the geometric centre of the oval pad, so as to bear equally in its pressure upon the deep and superficial rings. It is held by a screw, which, when slackened, allows of

Fig. 1156.

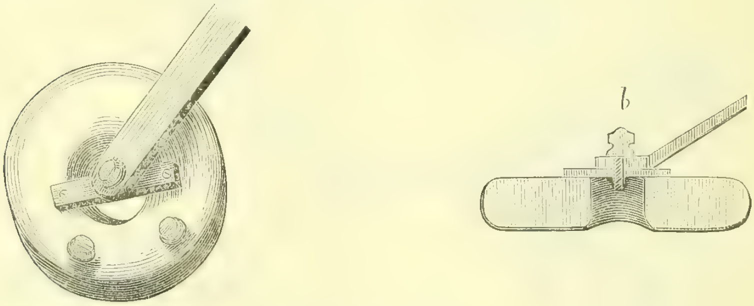


Horseshoe-pad for inguinal hernia.

rotation of the pad until the proper obliquity and right bearing upon the inguinal canal are obtained, when it can be fixed by tightening the screw with a small screw-driver. The studs on the ends of the horseshoe are for the attachment of the under strap, when this is needed. This strap, however, can in most cases be dispensed with after wearing the truss for a little while, till it adjusts itself under the heat of the body and settles into its proper place. In all cases, the side spring should lie in the slight depression below the crest of the ilium, between it and the projection of the trochanter major. At the back it should lie evenly upon the sloping posterior surface of the sacrum, just avoiding the projecting posterior superior iliac spines. In a single truss, the free end of the spring may be connected by means of an eyed cross-strap with the stud on the centre of the pad. In a double truss the cross-strap is attached to both the central studs of the pad; in many cases, however, the cross-strap may be entirely dispensed with after a few months' wear. For use in hot countries, as in India, and also for bathing, the spring and pad may be entirely uncovered, no leather or soft material being necessary, except a linen or silken bag or covering for the truss, which may be removed at intervals for change and cleanliness. These trusses have been worn for years by scores of patients in the East and West Indies, with the greatest comfort and effect.

Truss for Direct Inguinal Hernia.—In some large cases of direct hernia, the cord becomes displaced so much to the outer side of the opening that it lies fairly across Poupart's ligament, and is out of the way of pressure by the truss-pad on the pubis. Under such conditions, the rupture can often be better controlled by a *circular* or *ring pad* of the same material as the former (Fig. 1157). In these pads the spring is attached by a screw to a cross-piece placed over the hole (*b*). The pressure in both these kinds of pad falls chiefly on the margins of the superficial ring. In the horseshoe form, it resembles the pressure of the fingers upon the rupture. There is no conical or plug-like pressure in the axis of the hernial opening. At the same time, it is more difficult for the rupture to escape by the sides of the pad. The sides of the ring and canal are thus pressed together instead of asunder, as by the action of the conical or convex pads, and the closure of the opening is promoted instead of being retarded. Both these forms of truss-pad may be used after the operation for the radical cure has been performed. They promote the gradual closure of the aperture and the contraction of the cicatrix, upon which the cure depends. They may be made of soft material in cases where ease and comfort are more to be looked for than a radical cure, or where the hard

Fig. 1157.



Ring-pad for direct hernia.

pressure cannot be borne. Frequently they are made of an India-rubber, air or water cushion, supported by a thin steel plate of the required shape; or they may be stuffed with horse-hair, or with the material of the "moc-main" pad.

Trusses for Crural Hernia.—The conditions of effective truss-pressure in crural hernia are somewhat different from those in the inguinal variety. The hernial canal is a section of a tube placed nearly vertically (Fig. 1158 *A*), with its deeper (*d*) longer than its superficial wall (*c*), while its lower opening—the saphenous opening—presents a sloping surface like the oblique section at *b*. The pressure of the truss should be so placed as to close up the upper end of the tube, at *a*, by pressure upon Poupart's ligament, while at the same time the lower opening, at *b*, should be also protected to prevent the rupture from emerging through it as in figure *B*. These objects are best effected by a truss-pad of an egg-shaped outline, with the broad end placed upward, and resting upon the groove of the groin which marks the position of Poupart's ligament. The lower or smaller end rests on the saphenous opening, and is sloped off more obliquely than the upper (Fig. 1159 *B*), as seen in the section of the figure. The spring is fastened on by a screw in the centre of the pad, exerting its pressure equally over its surface. From the outside of the thigh, where the side-spring rests, below the iliac crest, the direction of the pad-end of the spring should be more depressed than in the truss for inguinal hernia; the pressure of the side-spring falls in the centre of the hernial canal, and protects equally the crural ring, or entrance of the rupture above, and the saphenous opening, its point of exit below. The saphena vein and the femoral vessels also escape pressure, which is always more or less injurious. The former vessel lies under the sloping lower border of the truss-pad. In several instances a radical cure has followed the persistent use of a pad of this kind made of vulcanite, but ordinarily an air or water cushion is preferred.

Fig. 1158.

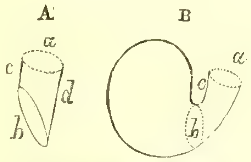
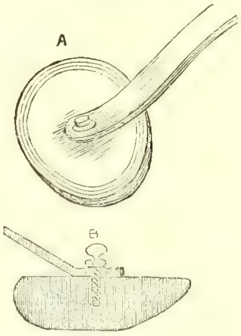


Diagram of crural canal.

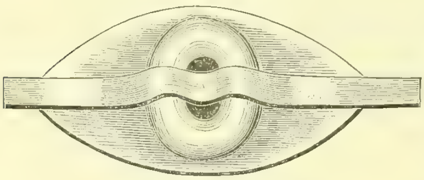
Fig. 1159.



Truss-pad for crural hernia.

Trusses for Umbilical Hernia.—For congenital umbilical hernia, the first application should be a piece of lint wrapped around a penny-piece, and kept on with a light flannel bandage, lightly swathing the infant's body, and kept from galling by a liberal use of powdered starch. When the child cries, or coughs, the pad should be kept in place by the additional pressure of the nurse's finger. When the tender skin is a little less irritable, the coin should be wrapped up in a piece of adhesive or soap plaster, with the sticky side outwards, and held firmly on the protrusion by straps of the same plaster, one inch broad, long enough to reach well over the sides of the body. As the child grows stronger, the straps should be made wider, and should encircle the body and cross each other behind. The front of the abdomen should be well covered both above the navel and below, to the extent of three or four inches, the skin being well protected by cotton-wool and dusting powder. If the skin shows signs of becoming irritated by the strapping, an India-rubber, seamless, circular belt, with a flat pad of lead, or a penny piece, placed in a pocket made over the navel, should be placed around the body, over the feet of the child, the skin being well protected by cotton-wool and dusting powder, and, after cleansing, being well dried with a soft, warm cloth. At a more advanced age, an India-rubber pad, such as is shown in the accompanying cut, from a belt made by Matthews, of Carey Street (Fig. 1160), may with advantage be substituted. It is made entirely of India-rubber, with an oval ring placed longitudinally on the sides of the hernial opening, and set in an oval thick piece placed with its long diameter transversely, the India-rubber strap crossing the ring, to which it is cemented, and filling up its oval opening so as to lie flat upon the skin. The same instrument-maker has an ingenious contrivance for this purpose, in which the opening of the pad is filled up by an India-rubber, globular ball, communicating by an aperture with the interior of an oval ring made of a thick India-rubber tube, bent into shape, and with its ends hermetically sealed. In this apparatus, when applied, any tendency to protrusion of the hernia at the navel is at once checked by the passage of air from the oval tube-ring into the globular obturator, distending it into a rigid ball which presses back the hernial protrusion like a spring, and which is acted on by the tension of an India-rubber body-belt pressing upon the tubular ring. A great number of patients have now been treated by this apparatus, with the result of a complete cure during the first two years of infancy.

Fig. 1160.



Truss for umbilical hernia.

In cases of young people with more confirmed herniæ, in whom the development of the recti abdominis muscles gives a tendency to bear off the pressure when the muscles contract, and so to allow the rupture to escape at the time when the compressed abdominal viscera tend to project the hernia most intensely, it is well to place the oval wings of the pad longitudinally, and to increase its thickness and mould it upon the linea alba for three or four inches, so as to fill up the hollow between the recti, above and below the hernia. The body-belt should also be made proportionately much broader than that represented in the woodcut. In adults, the body-belt may be of stout jean, with elastic sides, and made to lace up behind. In stout persons with umbilical or ventral herniæ, the whole of the protuberant abdomen should be covered with the body-belt, shaped like those worn after parturition. It should come well down to the folds of the groins, and should be so shaped as to be narrower at the sides and back, its lower border skirting closely the haunch bones, and being well protected against cutting or chafing the adipose folds of skin by a binding of soft morocco or wash-leather. The hernia should be covered and protected from an accidental blow, or pressure, by a thin plate of German silver, moulded in a gutta-percha mould upon the shape of the rupture, and large enough to cover it well, and to extend an inch or two beyond its margin. This plate should be lined with an air-pad of India-rubber, fitted to lie evenly upon the rupture, with a rounded margin made of a piece of wide and strong India-rubber tubing. A stout, broad belt, or fulcrum-band, with a buckle, should also be passed obliquely across the abdomen, from the back downwards to the front, so as to support the plate and air-pad, as well as the pendulous folds of skin below. This should be passed through loops of tape fixed to the belt and pad, and buckled at the back tightly enough to afford a convenient degree of support. Both this fulcrum-band and the broad abdominal belt may, in very fat persons, be made more comfortable and effective by being provided with shoulder-straps or braces, to sustain the weight of the flabby abdomen, and with an under strap or perineal band, made of a piece of India-rubber tubing of convenient thickness, to prevent the lower margin of the belt from shuffling upwards.

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